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HANDBOOK

1459

FOR

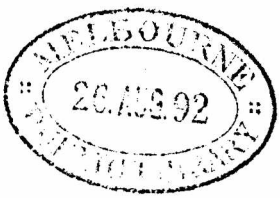
4-INCH R.M.L. JOINTED HOWITZER

(MARK I).

MULE EQUIPMENT.

LAND SERVICE.

1890.



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N.B.—This Handbook is corrected up to September, 1890. Any suggestions of alterations should be forwarded direct to A.D. of A., Woolwich.

DESCRIPTION OF HOWITZER.

(Plate I.)

Material		Steel.
Weight	breech portion, 209 lb.	600 lb.
	trunnion „ 192 lb.	
	chase „ 199 lb.	
Calibre		4 inches.
Length, total		57·45 inches.
„ breech portion		17·825 inches.
„ trunnion		11·3 inches.
„ muzzle		34·75 inches.
„ bore, 13 calibres		52·0 inches.
Chamber, diameter (mean)		3·73 inches.
Chamber, length		3·7 inches.
Preponderance, muzzle		4·5 lb.
Rifling, Number of Grooves		13
Rifling, Twist	increasing from 0 at breech to 1 turn in 25 calibres 38·7 inches from breech, remainder uniform, 1 in 25.	
Rifling, Length		47 inches.

Vent-Copper inclined at 84° to the axis, at one inch from end of bore.

The howitzer consists of three portions, one of them carrying the trunnion ring which forms a junction nut for locking the pieces together. The trunnion ring has a screw thread with two interruptions cut on its interior. A corresponding thread is cut on the exterior of the inner ends of breech and muzzle portion, so that ¼ of a turn of the trunnion ring effects the union.

Escape of gas at the joints is prevented by gas rings secured in position by split rings.

Feathers on the trunnion portion correspond with recesses on the breech and muzzle portion, to ensure the parts being correctly put together.

Putting together and Taking to Pieces.

The union of the three parts is effected by placing the trunnion portion over the breech portion, taking care that the feather on the former fits into the recess in the latter; the muzzle portion is then adjusted in a similar manner on the top of the trunnion portion, and the three parts locked together by a quarter turn of the junction nut; the direction in which the junction nut should revolve is indicated by the words "tighten" and "slacken" stamped above the trunnions. The index lines on the junction nut and on the breech and muzzle portions should correspond when the howitzer is put together; if the index lines on the junction nut are to the left of lines on the breech and muzzle portions the screw is not home; in this position the howitzer may be fired in a case of emergency, provided that the lines are not more than a quarter of an inch apart, but the lines must be examined after each round to see if the junction nut is working loose; if the index lines on the junction nut are to the right of the lines on the breech and muzzle no precaution is needed.

In cleaning the parts of the junction a rag and oil only should be used, and never any sand or gritty substance. Every care should be

taken to keep the screws, faces, slot, and groove in the gas ring free from dirt, rust, and burrs. In putting the gun together, attention to the following points is necessary; that—

1. The parts of junction are clean.
2. The gas rings are in their proper places, and held by the retaining rings.
3. The feathers fit into the slots, and the arrow-heads on the upper end of the inside of the trunnion piece, and the interior of the junction nut correspond.
4. The parts are brought together without a blow.
5. The junction nut is screwed home by hand, as far as possible.
6. The trunnion guard is on before setting home the junction nut with the hammer.
7. The index lines coincide when the junction nut is screwed home.

The following stores are supplied for use with this howitzer:—

Guard, trunnion, steel, annular	..	..	..	1
Hammer, handled	..	..	..	..	12 lb.	1
Lever gas ring	..	..	..	..	..	1
Bar, shifting	..	..	..	..	..	1
*Bar, lifting chase	..	..	..	..	..	1

SIGHTS.

(*Plates II and IIa.*)

Cross-bar Sights.—The howitzer is fitted on both sides with *cross-bar sights*; the tangent sights are provided with movable clamps, and drop into sockets in the jacket, being set vertically; the bars are graduated to 15°.

The fore-sights slide into grooves in projections formed for the purpose on the C hoop of the muzzle portion, and are secured by spring studs.

Reciprocating Sights.—Tangent reciprocating sights and fore-sights for use with them are also issued with these guns. The tangent sight and bracket are designed with a view of compensating for a difference in level of wheels, &c., or when the screw thread of the junction nut being worn, the index lines on the piece do not correspond. The bracket is of bronze and is fitted with a steel pillar, which slides into the sight socket of the gun. The sight socket, which is fitted with a level, can be revolved on the remainder of the bracket by means of a pinion and rack, the pinion being revolved by means of a milled head on the pinion spindle, on which is also a screw clamp. The sight-bar is triangular in section, graduated to 20°, and fitted with a clamp and slow motion nut, also a crosshead with deflection leaf, capable of giving $1\frac{1}{2}$° deflection right and left, worked by means of a screw fitted with milled heads. The deflection leaf has the service notch for use with the acorn on the fore-sight for rough laying, and an eyehole for use with cross wires of fore-sight for fine laying.

The fore-sight is of bronze fitted with a steel acorn on top and also cross wires for fine laying. This sight slides into the same grooves on C hoop as the crossbar fore-sight, being retained by a spring stud, which is released by raising the catches provided for the purpose.

* This implement was formerly termed the "Ring lifter."

CARRIAGE, MOUNTAIN, R.M.L. 4-INCH HOWITZER, MARK I.

STEEL, JOINTED.

(Plate III.)

The carriage is constructed to be readily taken to pieces, so as to form three loads of about 200 lbs. each, for transport.

For this purpose the axletree, centre transom with elevating gear, and the trail shoe are removable; the trail brackets are jointed in the centre to admit of their being folded up, and the front transom is jointed so that the trail brackets can be opened out and placed across a pack-saddle for travelling.

The castings which form the joint in the centre of the trail, have a vertical ⌊ shaped rib on the inner side of each bracket. These ribs when back to back make up one of ⊥ section, along which the centre transom is slid, thus uniting the two parts, and completing the trail. A screwed pin passes through the trail and centre transom underneath, and secures the latter in position.

The centre transom is in one casting of steel, with bearings and recesses for the elevating gear, guides for the elevating arc, and ⊤ channels to suit the ribs previously described.

The front transom consists of two castings formed with bearings for the axletree and trunnions; and with knuckles in the centre which form a joint by which the two castings are connected.

The trail shoe and dismounting block are in one casting of steel. This casting is fixed in position by hooks on the trail, and a pin which passes through the point, where it is secured by a split key.

The axletree is a solid forging with special arms. It is turned to fit in the front transom, where it is secured by a pin.

The elevating gear consists of a worm spindle, which, when actuated by a hand wheel, transmits motion through a worm wheel to an arc pivoted to the cascable of the howitzer. The worm wheel is fitted with a friction cone, which is adjusted by nuts to give the necessary slip for preventing damage to the gear.

Each wheel is furnished with a brake shoe to check the recoil of the carriage. The shoe is attached to the nave by steel ropes, and to the trail by a brake rope which prevents it going too far forward during recoil, and lifts it clear of the wheel when moving the carriage.

The trail is fitted with hooks by which the lower ends are secured to the capsquare loops when folded up, with hooks for the brake rope, and with chains and lanyards to prevent the securing pins from being lost.

		cwt.	qrs.	lbs.
Weight	carriage	3	3	5
	wheels (two)	1	2	0
	Total ..	5	1	5

	ft.	in.
Height of axis of gun	2	2⅞
Track of wheels	3	0
Maximum elevation	36°	
Maximum depression	7°	

INSTRUCTIONS FOR CARE AND PRESERVATION OF CARRIAGES.

All bright parts must be kept clean, and when not in use slightly greased.

The working parts of the elevating gear must be kept clear of clotted oil, dirt, and corrosion, and the bearings well lubricated. The friction cone must be occasionally removed and cleaned to prevent its setting in the worm wheel, but on no account must it be lubricated when it is replaced.

The axletree and grease chambers of the wheels should be frequently cleared from clotted grease, and all dirt and grit removed before lubricating. To ensure thorough lubrication the chambers must be kept filled with grease.

Defects or damage should be made good without delay. If the paint becomes rubbed off at any part it should be patched over as soon as possible.

The registered No. of these carriages must be quoted in all correspondence relating thereto to ensure identification.

PROJECTILES.

(*Plates IV and V.*)

Shell { Common, forged steel, Mark I.
Shrapnel, forged steel, Mark I.
Star, forged steel, Mark I.

Shot, case, Mark I.

Gas-check, Mark I.

The common and shrapnel shells are studless, the rotation being imparted by the gas-check which is issued attached to them; the star shell is studded.

DESCRIPTION OF PROJECTILES.

Common Shell, Mark I.

The shell is made of forged steel unturned. The base to a length of ·625 inch is reduced in diameter and made with a circular groove for attaching a gas-check. 16 radial serrations are formed on the base by which the gas-check imparts rotation to the shell.

The head is struck with a radius of two diameters, the point is truncated, bored out and screwed to receive the bush for the fuze.

The bush is made of gunmetal; it is tapped to the G.S. fuze-hole gauge.

The interior of the shell is lacquered.

Each shell is fitted with a gas-check.

The dimensions of the shell are as follows:—

	inches.
Diameter over body and gas-check	3·96
,, ,, projections on gas-check	4·06
Length of shell	12·55
,, total, over gas-check	12·62

	lbs.	oz.
Weight of shell empty without gas-check	15	4¼
,, ,, gas-check	0	14¼
,, ,, bursting charge P. and F.G. powder	3	7½
,, ,, fuze	0	6
Total weight of filled and fuzed shell	20	0

Shrapnel Shell, Mark I.

The body of the shell is made of forged steel unturned. The base to a length of ·625 inch is reduced in diameter, and made with a circlar groove for attaching the gas-check; sixteen serrations are formed on the base by which the gas-check imparts rotation to the shell.

The head of the shell is made of charcoal iron or Bessemer metal, ·212 inch thick, struck with a radius of two diameters; the point being truncated and bored out to receive a gunmetal socket. The socket is screwed to the G.S. fuze-hole gauge, and is attached to the head with soft solder.

The head is fitted with a wood block and attached to the body of the shell by means of six steel screws, four pins also being inserted to prevent it twisting. The holes for the twisting pins are slotted through to the bottom of the head. The screws and pins are made of steel wire ·134 inch diameter.

The shell is fitted with a cup of sheet iron tinned for containing the bursting charge, and a steel disc having a hole drilled in the centre screwed to receive a gunmetal tube, which is screwed at the top to receive a primer. The upper part of the tube and the socket in the head are joined by a conical tin tube.

The shell is lined with brown paper, and contains seventy-eight mixed metal balls (sixteen per lb.) the interstices being filled in with resin.

Each shell is fitted with a gas-check.

The dimensions of the shell are as follows :—

	Inches.
Diameter over body and gas-check.. ..	3·96
„ „ projections on gas-check ..	4·06
Length of shell	9·0
„ total, over gas-check	9·07

	lbs.	ozs.
Weight of shell empty without gas-check	17	$10\frac{1}{2}$
„ „ gas-check	0	$14\frac{1}{4}$
Capacity of the shell	0	$3\frac{1}{4}$
Weight allowed for fuze..	1	4
Total weight of filled and fuzed shell..	20	0

Case shot, Mark I.

The case is made of X.X.S. tin in three longitudinal pieces, lap-jointed and soldered together with soft solder. The top end is notched to a depth of about ·3 inch.

The bottom is made of X.X.S. tin, it is soldered to the sides of the case which are turned over it. A ring of wrought iron ·109 inch thick is riveted to the bottom outside, and a disc of sheet iron ·22 inch thick is laid loose inside the case.

The case has an inside lining of wrought-iron ·22 inch thick (the lining being in three segments), 6·6 inches in length, and contains 193 mixed metal balls (16 per lb.), the interstices being filled in with an equal proportion of clay and sand.

The top is made of sheet iron, tinned, ·165 inch thick; it is fitted with two wrought-iron staples, secured by being riveted to the underside of top, into which is fitted a wrought-iron handle for

lifting the case. The top is fitted to the case by turning over the notched ends and soldering with soft solder.

The dimensions of the case are as follows:—

	inches.
Diameter over body	3·95
Length of case	7·3
„ total over handles	8·0
	lbs. oz.
Total weight	20 0

Star Shell, Mark I.

The body is made of steel ·275 inch thick at the sides and ·6 inch thick at base. Holes are drilled and undercut in the body of the shell near the base into which thirteen copper studs are pressed and planed to a twist of one turn in 100 inches.

The head is made of charcoal iron or Bessemer metal· 212 inch thick struck with a radius of 1·5 diameter, the point being truncated, bored out and screwed to receive a gun-metal socket. The socket is screwed to the G.S. fuze-hole gauge and is attached to the head with soft solder, the lower end of the socket is made to fit over the upper part of brass tube passing through the centre of the shell and communicating with the base. The tube is perforated with twelve holes in the form of a spiral, and the lower part screwed into the centre of a wrought-iron disc ·15 inch thick tinned and perforated with thirty holes ·125 inch diameter.

A disc of cannon cartridge paper with quick-match sewn on is inserted in the bottom of the shell below the wrought-iron disc.

The shell contains forty-two stars in three tiers of fourteen, made of the following composition:—

Nitrate of baryta	108 parts.
Chlorate of potash	72 „
Magnesium powder with 25% paraffin wax ..	96 „
Boiled oil	3 %

driven into brown paper cases, and primed at each end with mealed powder and quick-match. The stars are strengthened by having copper wire ·032 inch diameter woolded round them.

The head is fitted with a wood block and attached to the body of the shell with four brass screws, four iron pins also being inserted to prevent the head twisting. The holes for the twisting pins are slotted through to the bottom of the head.

The dimensions of the finished shell are as follows:—

	inches.
Diameter over body	3·96
„ „ studs	4·06
Length of shell	12
	lb. oz.
The weight allowed for fuze	1 4
The weight of filled shell	14 15½
The weight of filled and fuzed shell, is to be..	16 3½

Gas-check, Mark I.

The gas-check is made of an alloy of 100 parts of copper to three of zinc, and has thirteen projections on the outer circumference to fit the grooves of the howitzer. It is attached to the shell by spinning the web into the groove round the base of the latter.

INSTRUCTIONS FOR FILLING SHELL.

Common Shell.

Weigh out the proportions of P. and F.G. powders as laid down, and drop the P. powder into the shell pebble by pebble, then insert the funnel and pour in the quantity of F.G. powder laid down. The shell should be tapped on the exterior with a wooden mallet to assist the latter powder in filling up the interstices between the pebbles. When the shell is completely filled, the G.S. wad will be inserted, shalloon side downward, and the fuze hole plug screwed in.

Shrapnel Shell.

Remove the plug from the fuze-hole, and after seeing that the fuze-hole is clear of any dirt, &c., insert the leather funnel and pour in the bursting charge, which has been previously weighed out or measured. This must be done gradually, for if the whole of the powder is put in at once the tube will probably become choked. The shell should be tapped on the side with a wooden mallet until the whole of the bursting charge has passed down the tube, taking care that none of the powder is left at the bottom of the socket. Drop in the metal primer, and by means of the large Shrapnel screw-driver screw it tightly into the tube, and then screw in the fuze or plug as may be required.

Star Shell.

Tear off the canvas cover from the top of the shells.

Unscrew and remove the metal plug.

Screw in the time fuze and set it as described on p. 11. The safety pins must not be removed until the shell is in the bore.

The cartridge and shell should be rammed home simultaneously.

With from 15° to 20° elevation, and fuze set from 12 to 14, and stars will range from 700 to 800 yards. The elevation and length of fuze must be reduced for shorter ranges to such extent as may appear to be desirable.

NOTE.—A fair or contrary wind has considerable influence on the range of the stars.

FIXING PLUGS AND FUZES, AND SECURING SHELLS.

When plugs or metal fuzes are screwed into shells they will be lubricated with Field's grease, No. 3, if for use at home stations or in British North America. Price's composite grease is to be employed at all other stations.

DISTINGUISHING MARKS.

All Shrapnel shell will be painted with a red tip 1 inch deep.

All steel shot or shell will have a white band $\frac{1}{2}$ inch wide painted round the head 1 inch from top; in the case of Shrapnel this white band will be immediately below the red tip. F.S. will be stamped on the base of forged steel projectiles.

All filled shell will have a red band ½ inch wide painted round the head 1½ inch from top: in the case of steel shell this band will be immediately below the white band. They will be marked with the date of filling, and also the monogram of the station, except when filled by the Royal Artillery.

Filled shell will be marked with the letter P if filled with P and F.G. The colour of the paint will be red on a black ground, or black on a red ground.

Projectiles which are to be used for practice only will be marked with a yellow band, ½ inch wide, round the body.

Shells which have been emptied will be marked on the head with the letter E in red paint, and the monogram denoting the station.

Examination of Filled Shells.

Whenever it may be considered necessary to examine the interior of filled shells, and it is found that the powder is caked from the effects of damp, the common shells, will be emptied, cleaned out, and re-filled; the Shrapnel will be exchanged.

Shells, Common, filled with Loose Powder.

Remove the fuze-hole plug, pass the "hook G.S. wads" through the hole in the centre of the wad, and draw the wad out of the fuze-hole: if the powder charge is in a serviceable condition, insert a new papier-mâché wad, and replug the shell as directed in instructions for filling. If the powder charge is found to be caked from the effects of damp, empty the shell and clean it out. If the powder is so caked that it will not run out of the shell, or if any powder remains adhering to the interior of the shell, fill the shell with boiling water and allow it to stand for about five minutes, then pour out the water and fill up again with boiling water. After standing for fifteen minutes more, the shell may be emptied, using the copper scrapper for shells to facilitate the removal of the wetted powder. The scraper must not be applied until after fifteen minutes have elapsed after the second quantity of boiling water has been poured in. When the shell is perfectly dry, refill with serviceable powder. If necessary, the addition of boiling water will be repeated till the whole of the bursting charge has been extracted.

Shells, Shrapnel.

Remove the fuze-hole plug, unscrew the primer with the "driver screw Shrapnel large Mark III," and lift out the primer with the "pincers Shrapnel primers"; turn the shell nose downwards, and if the powder charge flows out and is serviceable, refill and replace primer and plug, a new primer may be inserted if necessary; the shell should be well shaken if the powder does not come out quite freely, as a portion of the powder may possibly be jammed in the tube; if the powder cannot be extracted as above, being caked from the effects of damp, &c., the primer and plug will be replaced, and steps taken for the exchange of the shell.

FUZES.

Percussion, direct-action, No. 3. Marks II and III.
Time sensitive, middle, No. 24.

Direct-Action Fuze.

Plates VI and VII.

Mark II.—The fuze is made of gunmetal, turned all over and screwed below the head to suit G.S. fuze-hole; the interior is bored out at the lower end for the powder charge, and screwed to receive base-plug; the upper part of fuze is charged with detonating composition, over which is a brass disc ·005 inch thick, and the holes communicating with magazine filled with powder priming; the fuze is fitted with a steel needle passing through and secured in a copper suspending disc ·032 inch thick. The lower part of the fuze is filled with pistol powder and covered with a disc of shalloon.

Mark III is identical with Mark II internally, but resembles the Pettman G.S. externally. It is closed at the top with a left-handed screw plug, instead of the cap as in Marks I* and II.

Mark I* is essentially the same as Mark II, and is the pattern to which the Mark I have been converted.

These fuzes require no preparation except the removal of the metal cap of Marks I* and II or plug of Mark III. Marks I* and II are screwed firmly into the fuze-hole by means of the "Key, plug, G.S.," and Mark III by the "Key, fuze, universal." The caps of Marks I* and II are fastened on to the head of the fuze by two double bayonet joints, which enable the caps to be used either in fixing or unfixing the fuzes. The caps can be removed by bringing the centre of the bayonet joints in line with the studs on the side of the head of the fuzes. The plug of Mark III has a left-handed screw thread. The cap or plug is not to be removed until after entering the shell into the muzzle of the gun.

Time, Sensitive, Middle. Mark I.

Plate VIII.

The fuze consists of body with stem, lighting pellet, two retaining-pellets with two spiral springs, needle, composition ring, dome, cap, two safety pins, base plug, and axial magazine.

It is made of gunmetal, the lower part of the body being screwed to G.S. gauge outside, and bored out inside to contain a magazine of M.G.[1] powder.

The composition ring is graduated on its periphery from 0 to 30, and reads to quarter units. An ⏚ is stamped on the ring to show the safety point, and when this coincides with the ⏚ on the body the fuze is set at safety. The cap which screws on to the top of the pillar is made hexagonal, to fit the "key, fuze, universal."

The fuze is set by loosening the screw cap on the top of the screw, by means of the "key, fuze, universal," and turning the dome and ring till the required graduation on the collar coincides with the arrow head on the body, the screw cap is then tightened. The safety

pins are then withdrawn at the moment of loading. On discharge, the centrifugal action causes the retaining pellets to fly out, releasing the lighting pellet which flies by centrifugal force against the needle, firing the detonator, which ignites the powder in the pellet and axial magazine, the latter lighting the quick-match in the composition ring.

The time of burning at rest is from 14·6 to 15·8 secs.

CHARGES.

18 oz., 12 oz., and 6 oz., R.F.G.^{2}, made up in 6 oz. cartridges of No. 1 class silk cloth without hoops.

Diameter, filled	..	..	2·5″
Length, filled..	..	..	2·8″

TUBE.

Tube friction copper solid drawn.

RANGE TABLE FOR 4-INCH R.M.L. HOWITZER.

Based on practice of 30/8/87, 7/9/87, 24/11/87, 2/2/88, and 7/6/88.

Projectile weight, 20 lb.

Charge, 18 oz., R.F. G.2					M.V. 835, f.s.				Jump, 18 minutes.			
										50 per cent. of rounds should fall within		
Range.	Elevation.	Deflection left.	Fuze scale. Middle sensitive.	5 minutes elevation increases or decreases the range by—	5 minutes will alter point of impact vertically or laterally at each range.	Drift right.	Remaining velocity.	Time of flight.	Angle of descent.	Length.	Breadth.	Height.
yds.	° ′	° ′		yds.	yds.	yds.	f.s.	secs.	° ′	yds.	yds.	yds.
0												
100	0 4	0 12	1·6	21	0·14	0·4	823	0·36	0 27	17	0·1	0·1
200	0 27	0 12	2·3	21	0·29	0·8	811	0·73	0 54	17	0·2	0·3
300	0 51	0 12	3·0	20	0·43	1·2	800	1·10	1 21	18	0·3	0·4
400	1 15	0 12	3·8	20	0·58	1·7	788	1·48	1 49	18	0·4	0·6
500	1 40	0 12	4·5	19	0·72	2·1	777	1·86	2 17	19	0·5	0·8
600	2 7	0 12	5·3	19	0·87	2·5	766	2 25	2 45	20	0·6	1·0
700	2 34	0 13	6·1	18	1·01	2·9	755	2·64	3 14	20	0·7	1·2
800	3 2	0 13	6·9	18	1·16	3·3	744	3·04	3 44	21	0·8	1·4
900	3 31	0 13	7·7	18	1·31	3·7	733	3·45	4 16	22	0·9	1·6
1000	4 1	0 13	8·5	17	1·45	4·1	722	3·87	4 49	23	1·1	1·9
1100	4 31	0 14	9·3	17	1·60	4·5	712	4·30	5 23	24	1·2	2·2
1200	5 2	0 14	10·2	17	1·74	5·0	702	4·73	5 58	25	1·4	2·6
1300	5 33	0 14	11·1	16	1·89	5·5	692	5·17	6 35	26	1·5	3·0
1400	6 4	0 14	12·0	16	2·03	6·0	682	5·62	7 12	27	1·7	3·4
1500	6 36	0 15	12·8	16	2·18	6·5	672	6·07	7 51	28	1·8	3·9
1600	7 8	0 15	13·7	15	2·32	7·1	662	6·53	8 30	29	2·0	4·4
1700	7 41	0 15	14·6	15	2·47	7·7	653	7·00	9 11	30	2·1	4·9
1800	8 14	0 16	15·5	15	2·61	8·4	644	7·47	9 54	31	2·3	5·5
1900	8 47	0 16	16·5	15	2·76	9·1	635	7·96	10 38	32	2·5	6·1
2000	9 21	0 17	17·5	14	2·91	9·8	626	8·45	11 23	34	2·7	6·8
2100	9 55	0 17	18·5	14	3·05	10·5	617	8·95	12 10	35	2·9	7·5
2200	10 30	0 18	19·5	14	3·20	11·3	608	9·46	12 59	36	3·1	8·3
2300	11 6	0 18	20·6	13	3·34	12·2	600	9·98	13 49	37	3·3	9·1
2400	11 42	0 19	21 7	13	3·49	13·2	592	10·50	14 40	39	3·5	10·1
2500	12 20	0 20	22·9	13	3·63	14·5	584	11·03	15 34	40	3·7	11·2
2600	12 58	0 21	24·2	13	3·78	16·0	576	11·57	16 32	42	4·0	12·4
2700	13 37	0 22	25·4	12	3·92	18·0	568	12·11	17 32	43	4·2	13·7
2800	14 17	0 24	26·7	12	4·07	20·0	560	12·66	18 34	45	4·4	15·1
2900	14 58	0 26	27·9	12	4·21	23·0	552	13·22	19 40	47	4·6	16·7
3000	15 39	0 28	29·2	12	4·36	26·0	544	13·78	20 49	49	4·9	18·4
3100	16 22	0 32	—	11	4·51	30·0	536	14·35	22 0	50	5·1	20·3
3200	17 8	0 36	—	11	4·65	34·0	528	14·92	23 13	52	5·4	22·3
3300	17 56	0 40	—	11	4·80	39·0	520	15·50	24 29	54	5·7	24·6
3400	18 45	0 44	—	10	4·94	47·0	512	16·08	25 50	56	6·0	27·0
3500	19 37	0 50	—	10	5·09	52·0	504	16·67	27 16	58	6·2	30·0
3600	20 31	0 56	—	10	5·23	60·0	496	17·26	28 48	60	6·5	33·2
3700	21 28	1 2	—	9	5·38	69·0	489	17·86	30 23	62	6·8	36·7
3800	22 33	1 9	—	9	5·52	78·0	482	18·46	32 3	65	7·1	40·8
3900	23 41	1 16	—	9	5·67	87·0	475	19·07	33 51	67	7·4	45·1
4000	24 57	1 24	—	9	5·81	98·0	468	19·69	35 47	69	7·7	49·6

RANGE TABLE—*continued.*

Charge, 12 oz., R.F. G.[3]					M.V. 702, f.s.				Jump, 20 minutes.			
Range.	Elevation.	Deflection left.	Fuze scale.	5 minutes elevation increases or decreases the range by—	5 minutes will alter point of impact vertically or laterally at each range.	Drift right.	Remaining velocity.	Time of flight.	Angle of descent.	50 per cent. of rounds should fall within		
										Length.	Breadth.	Height.
yds.	° ′	° ′		yds.	yds.	yds.	f.s.	secs.	° ′	yds.	yds.	yds.
0												
100	0 14	0 11	—	14	0·14	0	692	0·46	0 38	7	0·1	0·1
200	0 48	0 11	—	14	0·29	1	682	0·93	1 18	9	0·1	0·3
300	1 24	0 11	—	13	0·43	1	672	1·40	2 0	11	0·2	0·5
400	2 0	0 11	—	13	0·58	1	662	1·88	2 43	13	0·3	0·8
500	2 38	0 12	—	12	0·72	2	653	2·36	3 28	15	0·4	1·1
600	3 16	0 12	—	12	0·87	2	644	2·85	4 16	18	0·5	1·4
700	3 56	0 12	—	12	1·01	2	635	3·34	5 6	21	0·7	1·8
800	4 39	0 12	—	11	1·16	3	626	3·85	5 58	24	0·9	2·3
900	5 24	0 13	—	11	1·31	3	617	4·37	6 53	27	1·1	2·8
1000	6 11	0 13	—	11	1·45	4	608	4·90	7 51	31	1·3	4·5
1100	6 59	0 14	—	10	1·60	4	600	5·44	8 53	35	1·5	5·5
1200	7 48	0 15	—	10	1·74	5	592	6·00	10 0	40	1·7	8·0
1300	8 40	0 16	—	9	1·89	6	584	6·56	11 13	45	2·0	10·0
1400	9 34	0 18	—	9	2·03	7	576	7·13	12 33	51	2·3	13·0
1500	10 30	0 20	—	9	2·18	8	568	7·71	13 57	57	2·6	16·0
1600	11 28	0 22	—	8	2·32	10	560	8·30	15 26	63	2·9	20·0
1700	12 29	0 24	—	8	2·47	12	552	8·91	17 32	71	3·3	25·0
1800	13 34	0 27	—	8	2·61	14	544	9·54	18 47	79	3·7	30·0
1900	14 42	0 29	—	7	2·76	16	536	10·20	20 38	88	4·1	35·0
2000	15 52	0 32	—	7	2·91	18	528	10·88	22 33	99	4·5	41·0
2100	17 4	0 34	—	7	3·05	20	520	11·59	24 31	111	5·0	48·0
2200	18 18	0 37	—	6	3·20	23	512	12·35	26 33	123	5·5	56·0
2300	19 36	0 40	—	6	3·34	26	504	13·15	27 40	136	6·1	66·0
2400	20 59	0 44	—	6	3·49	29	496	13·98	30 52	150	6·7	77·0
2500	22 26	0 48	—	5	3·63	33	489	14·84	33 8	163	7·3	91·0
2600	23 58	0 52	—	5	3·78	37	482	15·73	35 30	176	8·0	110·0
2700	25 32	0 56	—	5	3·92	42	475	16·65	37 56	189	8·8	137·0
2800	27 9	1 0	—	5	4·07	47	468	17·60	40 27	203	9·6	173·0
2900	28 54	1 4	—	4	4·21	53	461	18·58	43 4	217	10·5	210·0
3000	30 47	1 9	—	4	4·36	59	454	19·61	45 47	231	11·6	240·0

RANGE TABLE—*continued.*

Charge, 6 oz., R.F. G².					M.V. 452, f.s.				Jump, 19 minutes.			
Range.	Elevation.	Deflection left.	Faze scale.	5 minutes elevation increases or decreases the range by—	5 minutes will alter point of impact vertically or laterally at each range.	Drift right.	Remaining velocity.	Time of flight.	Angle of descent.	50 per cent. of rounds should fall within—		
										Length.	Breadth.	Height.
yds.	° ′	′		yds.	yards.	yds.	f.s.	secs.	° ′	yds.	yds.	yds.
0												
100	1 2	24	—	6	0·14	0·7	430	0·71	1 20	4·1	0·23	0·4
200	2 26	24	—	6	0·29	1·4	422	1·43	2 48	8·2	0·46	0·8
300	3 53	25	—	6	0·43	2·1	414	2·16	4 21	12·3	0·70	1·3
400	5 23	25	—	5·5	0·58	2·9	406	2·92	6 1	16·5	0 94	1·8
500	6 58	26	—	5·5	0·72	3·7	399	3·70	7 51	20·7	1·18	2·5
600	8 38	27	—	5	0·87	4·7	392	4·50	9 54	24 9	1·43	3·7
700	10 24	29	—	4·5	1·01	5·9	385	5·31	12 9	29·1	1·68	5·4
800	12 15	31	—	4·5	1·16	7·3	379	6·13	14 30	33·4	1·95	7·9
900	14 11	34	—	4·5	1·31	9·0	374	6·96	17 2	37·7	2·23	11·2
1000	16 15	38	—	4	1·45	11·1	369	7·81	19 51	42·0	2·53	15·1
1100	18 29	43	—	4	1·60	13·6	365	8·69	23 2	46·4	2·84	20·7
1200	20 55	48	—	3·5	1·74	16·6	361	9·61	26 52	50·8	3·16	27·2
1300	23 37	54	—	3	1·89	20·2	358	10·58	31 29	55·2	3·51	35·9
1400	26 39	61	—	3	2·03	24·5	355	11·63	36 42	59·7	3·89	47·0
1500	30 14	68	—	2·5	2·18	29·5	352	12·80	43 10	64·2	4·29	60·6
1600	34 39	76	—	2	2·32	35·3	350	14·11	50 30	68·7	4·71	66·5

FORMATION OF THE BATTERY, &c.

On "Boot and Saddle" being sounded, the gunners, except limber gunners, assist the drivers to saddle and get ready the mules; when "Fall in" is sounded, the battery falls in by subdivisions, and each subdivision is inspected by its No. 1; the drivers then proceed to the stables or lines in charge of the Nos. 1, load up the line gear loads, and get ready to file out; the gunners are marched to the gun-park by the quartermaster-sergeant, the howitzers are run out, the ammunition boxes placed on the ground in pairs ready for loading, commencing 5 yards in rear of the howitzers, and the remaining loads arranged by pairs in the most convenient position; when "Turn out" is sounded, the mules are marched to the parade ground by the officer on duty, or in his absence, the sergeant-major, the ammunition and pioneer loads are put on by the detachments, under the superintendence of the Nos. 1, and the baggage loads by the spare numbers, under the superintendence of the quartermaster-sergeant. As soon as the ammunition loads are on, the detachments fall in on their howitzers; the sergeant-major then gives the word "Front limber up," the howitzers are limbered up in the usual manner, and all the mules proceed to their places in line, the detachments falling in in front by word of command from the Nos. 1. The subaltern officers then inspect their divisions on foot, and the battery is told off and proved by the captain or officer on duty, as laid down for a field battery.

The first line consists of the seven howitzer and carriage mules, and the first ammunition mule, the second line of the seven relief gun and carriage mules and the relief ammunition mules, the third line of the remaining ammunition mules, the fourth line of spare carriage, and artificer's mules, and the bare-backed ordnance mules, and the fifth line of the water and baggage mules, the water mules of each subdivision leading; the pioneer mules fall in in the centre of their divisions in line with the first ammunition mules. The officers fall in as laid down for a Field Battery.

Distances and Intervals.

In line a distance of ½ yard is maintained from nose to croup of the mules of each line, and a distance of 8 yards between lines. In column of route the distance between lines is reduced to 1½ yards; it is advisable, in order to reduce the length of the column, to march, where practicable, in column of divisions; this can be done on any road of ordinary width. Detachments before moving off in column of route form the "Order of march," and the spare numbers are distributed at intervals amongst the baggage mules in order to assist in adjusting any loads that get out of place, and in tightening or letting out the breechings, when required.

The intervals between subdivisions in line are—

Full	..	..	25 yards.
Half	..	..	12½ „
Close	..	..	6 „

Movements in the Field.

The normal pace of manœuvre for Mountain Batteries is the "walk," but, if necessary, on an emergency, the pace can be increased to a

"trot." As a rule, the first line only will manœuvre. Drill movements for a Mountain Battery correspond to those laid down for a Field Battery. In "reversing" or "taking ground," detachments when at the "order of march," wheel round with the mules, each number remaining on his proper side; when at "detachments front," they wheel "right," "left," or "about" on their own ground; mules "reverse" or "take ground" on their own ground.

GUN DRILL.

The detachment consists of eleven numbers, and falls in two deep, two yards in rear of the howitzer, which is unlimbered.

To tell off.

Officer.	No. 1.
Tell off.	

At "Tell off," No 1 (who is on the right of his detachment) takes a pace to his front, turns to his left, and numbers himself 1; the right hand man of the rear rank numbers 2; the right hand man of the front rank 3; the second man from the right of the rear rank 4; the man in his front 5; and so on. After the detachment is told off, No. 1 falls in again on the right of the front rank.

This is the position of "Detachment rear."

The front is that direction in which the howitzer is pointed when in action, or to which the mules' heads are turned when limbered up.

Position of Detachment at the Gun, when in Action.

No. 1, at the point of the trail.
Nos. 2 and 3, in line with the muzzle outside the wheels, and one pace from them.
Nos. 4 and 5, in line with the breech, covering Nos. 2 and 3.
Nos. 6, one yard in rear of No. 1, and covering him.
No. 7, 5 yards in rear of left wheel, and covering it.
Nos. 8 and 9, with the first ammunition mule.
No. 10, 5 yards in rear of the right gun wheel.
No. 11, 5 yards in rear of the first ammunition mule.

To take Post on the Gun from Detachment Rear.

Officer.	No. 1.
Take post.	Right turn. Double march.

The numbers double to their places in action and halt, facing to the front.

No. 1 attaches the sight pocket to his belt.
No. 5 „ the tube pocket „
Nos. 2 and 3 attach the linch-pin and washer pockets to their belts.
All pockets are carried on the belts on the right side.

If the sponge and rammer are not strapped to the trail, No. 4 places them on the ground outside Nos. 2 and 3.

Nos. 1 to 7 and 10 strap on knee caps.

General Duties in Action.

No. 1 commands, fixes sights, superintends setting of fuzes, and lays
No. 2 sponges, rams home, and mans right wheel.
No. 3 loads, removes safety pin from fuze; when in the bore, mans left wheel.
No. 4 attends to vent, pricks cartridge, mans right wheel, and raises drag shoe in running back.
No. 5 fires, mans left wheel, and raises drag shoe in running back.
No. 6 ships and unships handspike, runs up, and traverses.
No. 7 supplies No. 3 with cartridges from No. 8.
No. 8 sets and fixes fuzes (except when shells are fuzed at the howitzer), serves out ammunition to Nos. 7 and 10.
No. 9 assists No. 8 in serving out ammunition.
No. 10 supplies No. 3 with projectiles from No. 8.
No. 11 brings up ammunition mules as required.

Action.

Officer.	No. 1.
Action.	Action.

No. 1 takes out tangent and foresights from pocket, adjusts fore sight in socket, satisfies himself that the howitzer is properly screwed home, and that the fittings are in good order, and kneels on the right knee on the left of the handspike.

No. 2 takes up rammer, turns to his left, kneels on his left knee, unscrews the coupling hook of rammer, screws rammer to sponge, and seizes it in the right hand by the centre, rammer head to the rear.

No. 3 takes up sponge, turns to his right, kneels on his right knee, unscrews coupling hook of sponge, and screws sponge to rammer.

No. 4 turns to his left, and kneels on his right knee.

No. 5 turns to his right, kneels on his left knee, takes lanyard from tube pocket and puts it under his belt.

No. 6 ships handspike, and kneels on his left knee, ready to traverse.

No. 7 kneels on his left knee.

Nos. 8 and 9 open the near ammunition box, and prepare to issue ammunition.

No. 10 kneels on his right knee.

Load.

	Officer.		No. 1.
No. 1 gun.	With—oz. charge.	Front§—degrees deflection.‖	With—oz. charge.
	Shell.*	Right§—degrees ,,	Shell.*
	Shrapnel.† Fuze.‡	Left§ —degrees ,,	Shrapnel.† Fuze.‡
	Star Shell. Fuze.‡		Star Shell. Fuze.‡
	Case.		Case.
	Blank cartridge.		Blank cartridge.
	Load.		Load.

* Common shell and percussion fuze always understood unless otherwise ordered.
† Time fuze always understood unless otherwise ordered.
‡ Here say number of graduations required.
§ Here indicate target.
‖ Here order No. of minutes' deflection necessary.

No. 1 repeats the word of command, as to the nature of projectile and charge, sets his tangent scale, clamps it, places it in the socket, examines the shell, when fuzed with time fuze, fixes and sets fuze, when shell are fuzed at the howitzer, hands it to No. 3, and lays.

No. 2 brings the sponge to a horizontal position in front of the bore, inserts sponge head (right hand back up, in centre of stave, left hand back down, close to sponge head), shifts the left hand to the right, forces the sponge up the bore until the left hand meets the face of the piece, shifts both hands to the rammer head, and forces the sponge hard home. He then gives the sponge two half turns, by first lowering and then raising his wrist, at the same time pressing the sponge hard against the bottom of the bore. The sponge is then withdrawn in two motions and reversed, the right hand holding the sponge by the centre, and the left hand meeting the rammer head opposite the bore.

When No. 3 has placed the charge in the bore, and removed the safety pin, No. 2 introduces the rammer head into the bore, reaches out to the full extent of his arms, and rams home in one motion, with a firm pressure, left hand back up, right hand back down. He then quits the rammer, and remains steady until No. 4 has pricked the carriage. The rammer is then withdrawn in one motion, and brought to its position in "action."

No. 3 slews his body to the right, and receives the cartridges from No. 7, and the projectile from No. 10. He inserts them in the bore as soon as the sponge is withdrawn, withdraws the safety pins, or uncaps.

No. 4 serves the vent with his left thumb, keeping his elbow raised and his fingers on the left side of the gun. When the charge is home he pricks the cartridge, and then serves the vent whilst the rammer is being withdrawn.

No. 5 takes the lanyard from his belt, hooks a friction tube to it, and holds the lanyard in his left, and the friction tube in his right hand.

No. 6 traverses under the directions of No. 1.

No. 7 receives the cartridges* from No. 8, and hands them to No. 3.

The cartridges while being carried up to the howitzer should be covered by the arms.

No. 8 prepares projectiles and supplies Nos. 7 and 10 with ammunition.

No. 9 assists No. 8.

No. 10 receives projectile from No. 8 and hands it to No. 3. If time fuzes are being used, the shell is handed to No. 1 for inspection.

To Lay the Gun.

No. 1, looking over the sights, with his right hand on the elevating wheel and his left hand on the cascable, elevates or depresses, as may be necessary, at the same time giving the word "Trail right" or "Trail left" to No. 6. The howitzer must be laid with a full sight, *i.e.*, the object, the apex of the foresight, and the top of notch of the tangent scale must be brought into a straight line; the eye being kept about 6 inches from the tangent scale. If the cross wires are used, the eye must be brought close to the hole in the tangent scale. When the

* The charge is made up in cartridges of 6 oz. each, of which 1, 2, or 3 are used as required.

gun is correctly laid, No. 1 gives the word "Take post." No. 6 traverses as directed.

N.B.—To ascertain the deflection required, when one wheel is higher than the other, if the reciprocating sight is not used, find out how many six-tenths of an inch there are in the differences of level of the wheels; multiply the number so found by the number of degrees of elevation given; the result will be the number of minutes deflection to be given to the higher wheel. In order readily to apply this rule, the pricker of each howitzer should be marked in division of six-tenths of an inch. The difference in level can be obtained by means of the sponge stave held across the wheels and measured with the pricker.

To Make Ready and Fire.

Officer.	No. 1.
Fire——rounds or Commence firing.	Ready. Fire. Run up (or back). Halt.

As soon as No. 1 gives the word "Ready," he removes the tangent scale, keeping it clamped; the numbers at the gun move clear of the recoil.

No. 5 presses a tube into the vent with his right thumb, extends the lanyard with his left hand, keeping his hand level with the vent, and looks towards No. 1.

At the word "Fire," No. 5, holding the lanyard taut with his left hand, chops it smartly with his right and replaces it under his belt. In the event of a miss-fire, No. 5 will place another tube in the vent from over the wheel and resume his position for firing.

No. 4, after the gun has been fired, clears the vent.

At the word "Run up," Nos. 1 and 6 lift at the handspike, Nos. 2, 3, 4, and 5 man the wheels.

At the word "Halt," the numbers resume their positions in "action."

N.B.—If it is necessary to control the recoil, drag-ropes are hooked to the washers and manned by all available numbers.

To Cease Firing.

Officer.	No. 1.
Cease firing.	Cease firing.

All the numbers stand up.

No. 1 unscrews the fore-sight, and replaces both sights in the pocket.

Nos. 2 and 3 unscrew the sponge from the rammer, screw on the coupling hooks and place them on the ground clear of the wheels.

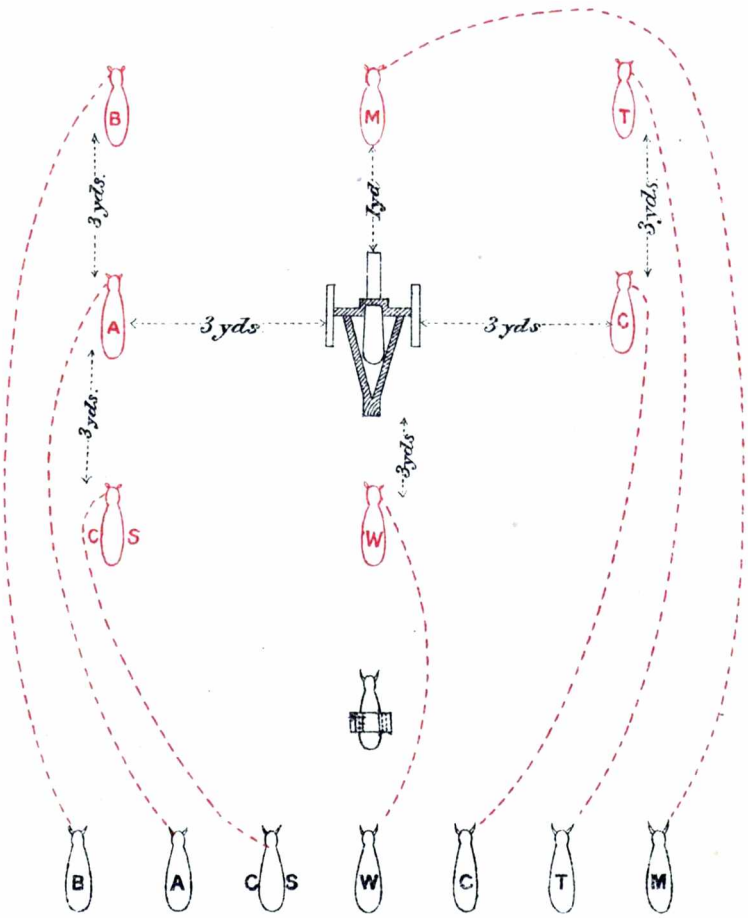
No. 5 replaces the lanyard in the tube pocket.

No. 6 unships the handspike, and places it on the ground clear of the right wheel.

Nos. 8 and 9 adjust ammunition and close the boxes.

FRONT LIMBER UP.

(1st position coloured black, 2nd red.)



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To Change Rounds in Action.

Officer.	No. 1.
Change rounds.	Change rounds.

In changing rounds No. 2 becomes 4
„ 4 „ 1
„ 1 „ 6
„ 6 „ 8
„ 8 „ 10
„ 10 „ 11
„ 11 „ 9
„ 9 „ 7
„ 7 „ 5
„ 5 „ 3.
„ 3 „ 2

When in Action to Form "Detachment rear."

Officer.	No. 1.
Detachment rear.	Detachment rear. Double march. Halt. Front.

No. 1 places himself two yards in rear of the howitzer, opposite the right wheel, and facing to the left; all the numbers double up and form facing No. 1, Nos. 2 and 3 marking time opposite No. 1, until the word "Halt" is given. At the word "Front," all the numbers turn to the front.

To Limber up.

Officer.	No. 1.
Front limber up.	Front limber up. Lift.

Limbering up is, as a rule, done only to the front. At "Limber up" the mules are brought up at a trot from the rear, and halted as follows:—

Carriage mule 3 yards on right of axle.
Axle mule 3 yards on left of axle.
Chase mule 1 yard in front of muzzle.
Trunnion mule 3 yards in front of carriage mule.
Breech mule 3 yards in front of axle mule.
Wheel mule 3 yards in rear of trail.
Case-shot mule 3 yards in rear of axle mule.

1st Lift.

No. 1 unkeys and removes the elevating arc. The shifting bar having been passed through the cascable by No. 6, the "bar lifting chase" is passed over the muzzle by No. 11, No. 1 gives the word "Lift"; Nos.

2 and 3 unkey the capsquares; Nos. 4 and 11 lift at the muzzle, and Nos. 5 and 6 at the breech. The gun is lifted out of the trunnion holes and placed vertically in the dismounting block; No. 2 unscrews the junction nut, No. 3 using the hammer to start it if necessary; the trunnion block having been placed by No. 2, No. 4 steadies the chase, No. 5 the breech.

2nd Lift.

When the junction nut is unscrewed, No. 2 gives the word "Lift." Nos. 4 and 11 then lift the chase off the trunnion piece and hold it up while No. 2 places the chase fid in the bore and No. 3 passes the lifter through the loop. Nos. 2, 3, 4, and 11 then place the chase on its cradle. Nos. 2 and 3 buckle the chase straps. No. 3 replaces the lifter, and No. 11 the "bar lifting chase." As soon as the chase is lifted off the trunnion piece No. 9 places the trunnion bearer in the bore; Nos. 7 and 8 seize the trunnion with their inward hands, facing to the front; No. 7 gives the word "Lift," and the trunnion piece is raised off the breech; No. 10 adjusts the cap and passes the lifter through the ring of the fid; Nos. 7 and 8 take hold of the lifter and the trunnion piece is placed on its cradle by Nos. 7, 8, and 9. No. 10 replaces the lifter and buckles the straps. No. 1 places the breech bearer in the bore, gives the word "Lift," and the breech is lifted by Nos 1, 5, and 6, and placed on its cradle, No. 6 withdrawing and replacing the shifting bar; Nos. 5 and 6 buckle the breech straps; No. 11 replaces the hammer and trunnion block.

3rd Lift.

Nos. 1 and 6 remove the elevating gear and adjust it on its cradle; No. 7 removes the trail shoe and places it on its cradle; Nos. 2 and 3 remove the linch-pins and washers and place them in the pockets; Nos. 8 and 9 lift at the breast of the carriage; Nos. 2 and 3 remove the wheels and place them on the cradle, No. 3 making fast the strap; No. 5 takes out the axle key, and Nos. 4 and 5 remove the axle and place it on its cradle; the carriage is folded over; the carriage bearers are brought up by No. 11 and adjusted by Nos. 8, 9, 10, and 11; No. 11 gives the word "Lift," and the carriage is placed on its cradle; the bearers are replaced by No. 11, the sponge and rammer by No. 4, and the handspike by No. 6.

N.B.—In placing the wheels the check rope is passed over the top of the implement box.

GENERAL DUTIES IN LIMBERING UP.

No. 1 commands, places breech bearer in bore, and lifts at it in placing breech on mule; unkeys and removes elevating gear, and assists to place it on mule.

No. 2 places muzzle fid in the bore, unkeys right capsquare in dismounting gun, supplies himself with trunnion block and places it on left trunnion if required, unscrews junction nut, adjusts fid, lifts at right of chase lifter, buckles front chase strap, removes right linch-pin and washer, removes and places right wheel.

No. 3 unkeys left capsquare, supplies himself with hammer and hammers left trunnion if necessary, adjusts chase lifter lifts at left of

it, and replaces it, buckles rear chase strap, removes left linch-pin and washer, removes and places left wheel, and buckles wheel strap.

No. 4 lifts at right of "bar lifting chase" steadies chase, removes and places axle on cradle, replaces sponge and rammer.

No. 5 lifts gun to dismounting block, steadies breech, lifts at left of shifting bar, buckles front breech strap, unkeys, removes, and places axle on cradle.

No. 6 passes shifting bar through cascable, lifts at right of it, buckles rear breech strap, withdraws and replaces shifting bar, removes elevating gear, and places it on cradle, replaces handspike, lifts at left trunnion, and left of trunnion lifter.

No. 7 lifts at left trunnion, and left of trunnion lifter, removes trail shoe, and places it on mule.

No. 8 lifts at right trunnion, and right of trunnion lifter, lifts at breast of carriage, adjusts and lifts at right front carriage bearer, buckles carriage strap.

No. 9 places trunnion bearer in bore, and lifts at it, lifts at breast of carriage, adjusts and lifts at left front carriage bearer.

No. 10 adjusts trunnion cap and trunnion lifter, makes fast straps, replaces lifter, adjusts and lifts at right rear carriage bearer.

No. 11 brings up and adjusts ring lifter, and lifts at left of it, replaces "bar lifting chase," hammer, and trunnion block, brings up and replaces carriage bearers, lifts at left rear carriage bearer.

In loading, the chase is reversed to the left, the breech to the right, the numbers facing to the rear.

POSITION OF DETACHMENT IN ORDER OF MARCH.

No.	1,	2 yards	in front	of	the chase mule.	
,,	2,	1 yard	on the right	of	the chase mule.	
,,	3,	,,	,, left	,,	,,	,,
,,	4,	,,	,, right	,,	trunnion	mule.
,,	5,	,,	,, left	,,	breech	,,
,,	6,	,,	,, right	,,	axle	,,
,,	7,	,,	,, left	,,	wheel	,,
,,	8,	,,	,, right	,,	carriage	,,
,,	9,	,,	,, left	,,	,,	,,
,,	10,	,,	,, right	,,	case shot	,,
,,	11,	,,	,, left	,,	first ammunition	mule.

In changing rounds when in "Order of march"—

No.	11	becomes	9
,,	9	,,	7
,,	7	,,	5
,,	5	,,	3
,,	3	,,	1
,,	1	,,	2
,,	2	,,	4
,,	4	,,	6
,,	6	,,	8
,,	8	,,	10, and
,,	10	,,	11

From the Order of March, to form Detachment front.

Officer.	No. 1.
Detachment front.	Double March. Halt, front.

No. 1 doubles obliquely to his right, to a point 5 yards in front of the chase mule, and 2 yards to the right. He turns to his left and gives the word "Double march"; the remaining numbers double up, Nos. 2 and 3 closing to 3 paces and wheeling to right opposite No. 1, the odd numbers covering No. 3, and the even numbers No. 2; when all have closed up, No. 1 gives the word "Halt," "Front," and the detachment halts, turns to the front and dresses by the right.

From Detachment Front, to form the Order of March.

Officer.	No. 1.
Form the Order of March.	Left turn. Double March.

The detachment turns to the left, wheels to the left, and the numbers double to their places in the order of march, halt, and turn about with the highest number.

From the Order of March, to come into Action (see Plate).

Officer.	No. 1.
"Action Front."	"Action Front." "Lift."

Coming into action is, as a rule, done only to the front. On the command "Action front," the chase mule remains stationary, the breech mule is brought up 3 yards to the left of the chase mule, the trunnion mule 3 yards to the right of the chase mule, the carriage mule 3 yards to the right of the position from which the trunnion mule moved, the axle mule to a similar position on the left, the wheel mule to 1 yard in rear of the carriage mule, the case shot mule to 1 yard in rear of the axle mule, the first ammunition mule to 10 yards in rear of the point of the trail of the gun when in "action."

Coming into action is the converse of "Limbering up," and is performed by a series of three lifts.

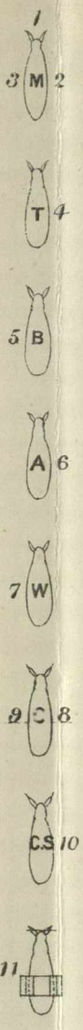
As soon as the loads are lifted off the mules, the drivers lead their mules forward until clear of the load, then reverse outwards, and move to their position in "action."

1st Lift.

Nos. 8 and 9 cast off the carriage straps; No. 11 brings up the carriage bearers; Nos. 8, 9, 10, and 11 adjust them; No 11 gives the word "Lift," and the carriage is lifted off the mule and unfolded; Nos. 8 and 9 hold up the breast; Nos. 4 and 5 lift off the axle and adjust it

4" R.M.L. Jointed Howitzer.

Order of March.



M. *Chase Mule*

T. *Trunnion Mule*

B. *Breech* ..... „ .....

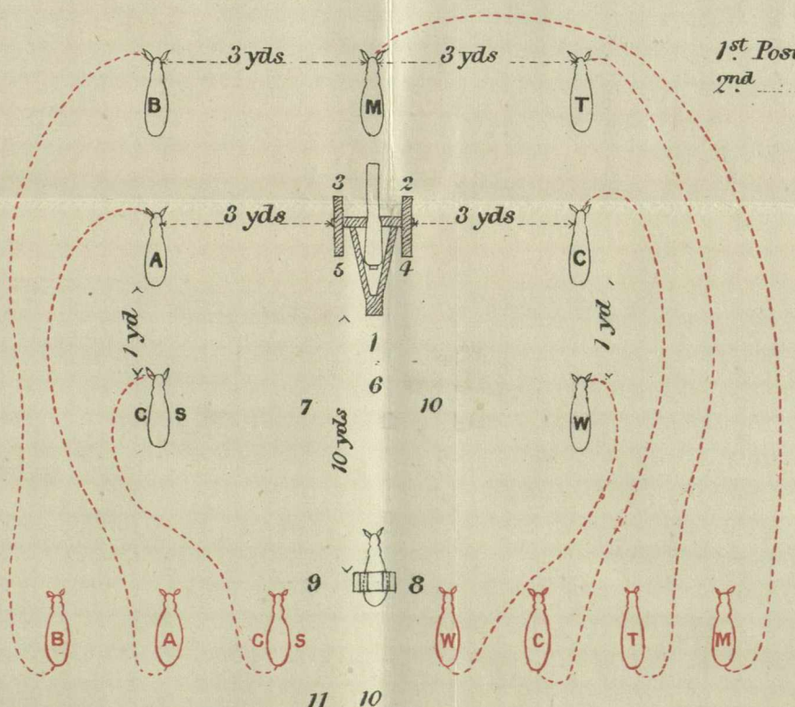
A. *Axle* ..... „ .....

W. *Wheel* ..... „ .....

C *Carriage* ..... „ .....

C.S *Case Shot* ..... „ .....

Halt, Action Front.



1st Position coloured Black.
2nd ..... „ ..... Red.

Judd & Co Ltd Lith. 73 & 75, Farringdon Rd & Doctors' Commons 426. 11. 89.

from the right side of the carriage, No. 5 keying up; Nos. 2 and 3 take off the wheels, place them on the axle, taking care that the check rope is above the trail, and adjust the linch-pins and washers; Nos. 1 and 6 take off and adjust the elevating gear, No. 1 keying up; No. 7 takes off and adjusts the trail shoe, and keys up.

2nd Lift.

Nos. 5 and 6 cast off the breech straps, No. 6 unships and passes the shifting bar through the cascable; No. 1 gives the word "Lift," and Nos. 1, 5, and 6 lift the breech and place it vertically in the trail shoe; No. 1 removes the bearer from the bore, and wipes the screw; Nos. 7 and 8 cast off the trunnion straps; No. 7 unships and passes the lifter through the ring of the fid to No. 8; No. 7 gives the word "Lift"; Nos. 7, 8, and 9 lift the trunnion piece off the cradle and hold it vertically over the breech; Nos. 7 and 8 seize the trunnion with their inward hands, and the lifter and cap are removed by No. 10. No. 9 withdraws the bearer; Nos. 2 and 3 cast off the chase straps; No. 3 unships and passes the chase lifter through the ring of the fid to No. 2; No. 4 removes the muzzle fid; No. 4 brings up and adjusts the "bar lifting chase"; No. 2 gives the word "Lift," and Nos. 2, 3, 4 and 11 lift the chase off the mule and hold it vertically over the trunnion piece; No. 3 then removes the lifter, and No. 2 the fid; the chase is then placed on the trunnion piece; No. 4 steadies the muzzle, No. 5 the breech; the junction nut is screwed by Nos. 2 and 3, No. 2 using the hammer, and No. 3 placing the trunnion block if necessary; when the lines on the breech and nut correspond, No. 1 gives the word "Home."

3rd Lift.

No. 1 gives the word "Lift"; Nos. 2 and 3 open the capsquares; Nos. 5 and 6 lift at the breech, Nos. 4 and 11 at the muzzle; the gun is lifted into the trunnion holes, and the capsquares are keyed up by Nos. 2 and 3; No. 6 removes the shifting bar, No. 11 the "bar lifting chase," and No. 1 adjusts the elevating arc.

The lifters, bearers, &c., are placed outside the wheels on their own sides by the numbers using them.

All the numbers take their places for "action."

GENERAL DUTIES ON COMING INTO ACTION.

No. 1 commands, lifts at breech bearer, and removes it from the bore, takes off, adjusts and keys up elevating gear, wipes screw, adjusts arc.

No. 2 casts off rear chase strap and wheel strap, takes off and places right wheel, and puts on linch-pin and washer, lifts at right of chase lifter, removes chase fid, screws up junction nut, using hammer if necessary, and keys up right capsquare.

No. 3 casts off front chase strap, takes off and places left wheel, and puts on linch-pin and washer, places and lifts at left of chase lifter, removes it, places and holds trunnion block if necessary, and keys up left capsquare.

No. 4 takes off and adjusts axle, removes muzzle fid, lifts at right of "bar lifting chase," steadies chase, lifts gun to trunnion holes.

No. 5 takes off, adjusts, and keys up axle, casts off front breech strap, lifts at left of shifting bar, steadies breech, lifts gun into trunnion holes.

No. 6 takes off and adjusts elevating gear, casts off rear breech strap, places shifting bar and lifts at left of it, lifts gun to trunnion holes.

No. 7 takes off and adjusts trail shoe, casts off front trunnion strap, ships and lifts at left of trunnion lifter and left trunnion.

No. 8 casts off right carriage strap, adjusts and lifts at right front carriage bearer, lifts at breast of carriage, casts off rear trunnion strap, lifts at right of trunnion lifter, and right trunnion.

No. 9 casts off left carriage strap, adjusts and lifts at left front carriage bearer, lifts at breast of carriage, lifts at trunnion bearer, and removes it.

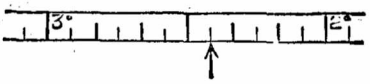
No. 10 adjusts and lifts at right rear carriage bearer, removes trunnion lifter and cap.

No. 11 brings up carriage bearer, adjusts and lifts at left rear carriage bearer, brings up and adjusts "bar lifting chase," lifts at left of it, lifts gun to trunnion holes, and removes ring lifter.

INSTRUCTIONS FOR USING WATKIN'S CLINOMETER.

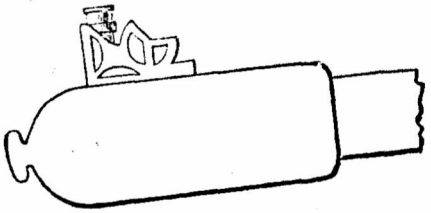
To read the angles marked on the drum.—The brass drum is marked in degrees, commencing at 0° on the top to 45° at the bottom. Each degree is subdivided into twelve parts; each small division therefore represents angles of 5 minutes.

The scale is read from right to left, thus—

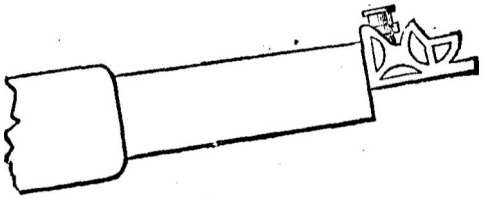


the reading opposite the arrow would indicate an angle of 2° 25′.

To lay a gun or howitzer at any angle up to 45°.—Unscrew the drum until the ↑ points to the elevation required, place the clinometer, thus—

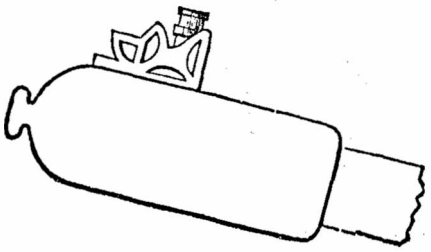


on the plane surface cut on the breech, or against the muzzle, thus—

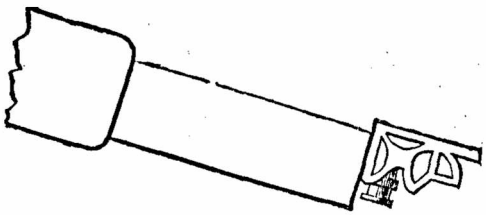


and elevate the piece until the bubble of the spirit-level is in the centre of the tube.

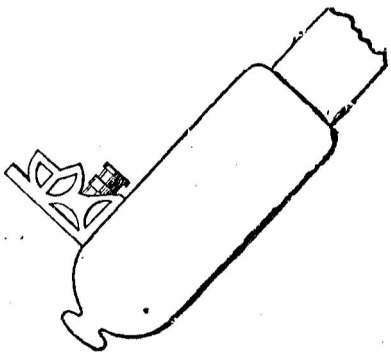
For angles of depression.—Proceed as above, but reverse the direction of the instrument, placing it thus on the breech of the gun—



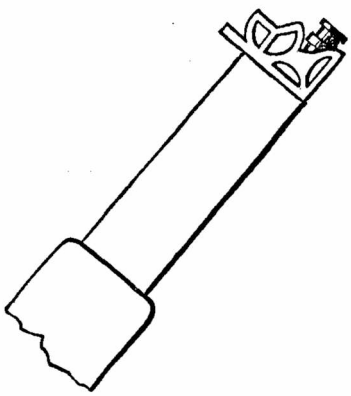
and thus on the muzzle—



For angles of elevation greater than 45°.—Subtract the angle of elevation required from 90°, unscrew the drum to this reading; thus, for 60°, unscrew the drum to 30°, and place the instrument on the breech of the gun, thus—



or on the muzzle, thus—



and elevate until the bubble is in the centre of its run.

DETAILS OF A 4-INCH R.M.L. JOINTED HOWITZER MOUNTAIN BATTERY.

War Establishment. Imperial Service.

Table I.	Battery.
Officers.	
Majors	1
Captains	1
Lieutenants	3
	5
Non-commissioned Officers, Men and Artificers.	
Sergeant-Major	1
Quartermaster-Sergeant	1
Sergeants	6
Corporals	6
Bombardiers	6
Trumpeters	2
Gunners	102
Drivers*	79
Muleteers (hired)†	170
	373
Artificers.	
Farriers	1
Collar-makers	3
Wheelers	3
Shoeing-smiths	3
	10
Total	388

Table II.	Battery.
Horses.	
Officers	5
Staff Sergeants	2
Farriers	1
Shoeing-smiths	1
Trumpeters	2
Collar-makers	1
Spare	1
Total horses	13
Ordnance Mules.	
Gun, 1st Line	18
,, relief	18
Carriages, 1st Line	6
,, relief	6
Axletrees, 1st Line	6
,, relief	6
Wheel, 1st Line	6
,, relief	6
Case shot, 1st Line	6
,, relief	6
Ammunition (6 relief)	102
Pioneers‡	3
Artificers	3
Spare carriage	3
,, ,, relief	3
Forge	1
Spare (bare-backed)	18
	217
Baggage Mules.	
Officers	4
Kits (213 non-commissioned officers and men)	36
Cooking utensils and rations	6
Water mules	6
Stores and half wrought	6
Office	1
Veterinary stores	1
Charcoal	1
Spare (1 saddled per subdivision)	6
	67
Total mules	284

Table III.	Battery.
Saddlery.	
Officers	5
Universal	7
Pack-saddles: ordnance	196
Pack-saddles: baggage	70
Total	278
Howitzers.	
4-inch R.M.L. of 600 lbs.	6
Carriages.	
Gun (including 1 spare)	7
Boxes.	
Ammunition	204
,, Clarkson's	14
Arms.	
Bayonet, sword, Martini-Henry	206
Carbines, B.L., Martini-Henry, with cleaning rods, jags, and sight protectors	18
Swords, cavalry	7
Pistols, revolvers	7
Ammunition.	
Rounds per gun: shell: common	64
Rounds per gun: shell: shrapnel	28
Rounds per gun: shell: star	4
Rounds per gun: shot, case	6
Total No. of rounds	102
Total No. of rounds per battery	612
Cartridges, S.A., ball, B.L. Martini-Henry carbine	360
Cartridges, S.A., revolver	168

* These drivers are for distribution as follows:—

1st Line mules (1 each)	48
Pioneer tool mules	3
Leading mules of relief line	6
,, ,, ammunition line	6
Spare carriage mules	3
Forge	1
Spare, 2 per subdivision	12
Total	79

† These muleteers are for distribution as follows:—

Relief line (except leading mules)	36
Ammunition line (except leading mules)	90
Artificer's tools	3
Spare carriage relief	3
Water mules	6
One per three bare-backed and baggage mules, except water mules, baggage, 61; bare-backed, 18	26
Spare, 2 per division	6
Total	170

‡ These mules carry baggage cradles.

DISTRIBUTION OF A MOUNTAIN BATTERY 4-INCH R.M.L. JOINTED HOWITZER.

War Establishment. Imperial Service.

	No. 1 Sub-division.	No. 2 Sub-division.	No. 3 Sub-division.	No. 4 Sub-division.	No. 5 Sub-division.	No. 6 Sub-division.	Total.
Officers and Men.							
Majors	1	...	...	...	...	...	1
Captains	...	...	...	...	...	1	1
Lieutenants	...	1	1	...	1	...	3
Sergeant-Majors	1	...	...	...	...	...	1
Quartermaster-Sergeants	...	...	...	...	...	1	1
Sergeants	1	1	1	1	1	1	6
Corporals	1	1	1	1	1	1	6
Bombardiers	1	1	1	1	1	1	6
Trumpeters	1	...	...	...	...	1	2
Gunners	17	17	17	17	17	17	102
Drivers	15	13	12	12	13	14	79
Farriers	...	1	...	...	...	...	1
Collar-makers	...	1	...	1	1	...	3
Wheelers	...	1	1	...	1	...	3
Shoeing-smiths	1	...	...	1	...	1	3
Muleteers	29	28	28	28	28	29	170
Total	68	65	62	62	64	67	388
Horses.							
Majors	1	...	...	...	...	...	1
Captains	...	...	...	...	...	1	1
Lieutenants	...	1	1	...	1	...	3
Sergeant-Majors	1	...	...	...	...	...	1
Quartermaster-Sergeants	...	...	...	...	...	1	1
Trumpeters	1	...	...	...	...	1	2
Farriers	...	1	...	...	...	...	1
Collar-makers	...	...	...	...	1	...	1
Shoeing-smiths	...	...	...	...	...	1	1
Spare	...	...	1	...	...	...	1
Total	3	2	2	...	2	4	13
Mules.							
Ordnance—							
Gun	6	6	6	6	6	6	36
Carriage	2	2	2	4	2	2	14
Wheel	2	2	2	2	2	4	14
Axle	4	2	2	2	2	2	14
Case shot	2	2	2	2	2	2	12
Ammunition	17	17	17	17	17	17	102
Pioneer	1	...	1	...	1	...	3
Artificer	...	1	1	...	1	...	3
Forge	...	1	...	...	...	...	1
Spare	3	3	3	3	3	3	18
Total	37	36	36	36	36	36	217
Baggage.							
Officers	1	1	1	...	...	1	4
Kits	6	6	6	6	6	6	36
Cooking utensils and rations	1	1	1	1	1	1	6
Water	1	1	1	1	1	1	6
Stores and half wrought	1	1	1	1	1	1	6
Office	1	...	...	...	...	...	1
Veterinary Stores	...	...	...	1	...	...	1
Charcoal	...	...	...	...	...	1	1
Spare	1	1	1	1	1	1	6
Total	12	11	11	11	10	12	67
Grand total of mules	49	47	47	47	46	48	284
Saddlery.							
Saddlery, officers sets	1	1	1	...	1	1	5
,, universal ,,	2	1	...	...	1	3	7
Pack-saddlery, ordnance ,,	33	33	32	33	32	33	196
,, baggage ,,	13	11	12	11	11	12	70
Total ,,	49	46	45	44	45	49	278

DETAIL OF PACKING AND WEIGHTS OF EQUIPMENT—HARNESS.

Description of Mule.	Articles carried.	Weight. lb.	Weight. oz.
Ordnance mules.	1 breeching, with loin strap ..	3	3
	1 chain, collar, G.S..	2	7
	1 collar, breast, with neck strap ..	2	9
	1 crupper, with metre strap ..	1	2
	2 girths, web	2	12
	1 set of straps, line gear, long* ..	2	0
	4 straps, metre, girth	2	4
	2 straps, metre, surcingle	1	2
	1 surcingle, web	0	14
	1 collar, head-stall, with brow band and throat lash	1	12
	1 bit. bridoon, without rein ..	0	14
	1 rein, leather, with iron stops ..	0	10
	For relief mules, in addition to above, 1 strap for securing cloaks and line gear, weight 6 oz. ..	0	6
	Total	21	15
Baggage mules.	1 set of baggage ropes		
	1 breeching	1	4
	1 breast collar	1	5
	1 collar, head-stall, complete ..	1	5
	2 girths, web	1	2
	1 bit, bridoon	1	8
	1 set of straps, line gear, long ..	2	0
	1 chain, collar, G.S.	2	7
	1 crupper, with hip straps.. ..	1	0
	1 surcingle, leather..		
	A set of line gear consists of—		
	1 blanket (folded and rolled round)	8	2
	1 heel rope, with 2 shackles ..	1	8
	1 iron peg	2	8
	1 wooden peg	1	4
	1 surcingle web, with pad ..	0	10
	1 brush, horse	0	11½
	1 sponge	0	0¾
	1 currycomb	0	11¾
	1 bag line gear	0	8
	1 stick, head	1	7
	Also 1 sack corn jute, 5-bushel, weight 4 lb. 8 oz., for 4 baggage mules, in each sub-division.		
	Total	29	6

N.B.—Each set of line gear is carried, rolled in the blanket, one on each side of the relief ordnance cradles, and one on the top of each ammunition artificer and baggage cradle.

* Not carried on 1st line mules.

DETAIL OF PACKING AND WEIGHTS OF EQUIPMENT—HARNESS—*continued.*

Description of Mule.	Articles carried.	Weight. lb.	oz.
Breech mule.	1 set of M.B. harness	19	9
	1 breech cradle	66	15
	Load consisting of—		
	1 breech portion	225	8
	1 jointed sponge		
	1 shifting bar		
	1 bearer		
	2 breech straps		
	Total	312	0
Trunnion Mule.	1 set of M.B. harness	19	9
	1 trunnion cradle	73	7
	Load consisting of—		
	1 trunnion portion ..	215	8
	1 bearer		
	1 cap		
	1 lifter		
	1 trunnion strap		
	Total	308	8
Chase mule.	1 set of M.B. harness	19	9
	1 chase cradle	64	15
	Load consisting of—		
	1 chase portion	224	12
	2 bearers		
	2 caps with fids		
	2 chase straps		
	Total	309	4
Carriage mule.	1 set of M.B. harness	19	9
	1 carriage cradle	62	7
	Load consisting of—		
	1 carriage	215	12
	2 carriage straps		
	Total	297	12

DETAIL OF PACKING AND WEIGHTS OF EQUIPMENT—HARNESS—*continued.*

Description of Mule.	Articles carried.	Weight. lb.	Weight. oz.
Axle mule.	1 set of M.B. harness	19	9
	1 axle cradle	73	7
	Load consisting of—		
	1 axle		
	1 elevating gear		
	1 pin for ditto	195	0
	1 elevating arc		
	1 pin for ditto		
	Total	288	0
Wheel mule.	1 set of M.B. harness (without surcingle)	17	9
	1 wheel cradle	71	15
	Load consisting of—		
	2 wheels with drag shoes..		
	1 check rope		
	1 trail piece	196	8
	4 carriage bearers.. ..		
	1 wheel strap		
	Total	286	0
Case shot mule.	1 set of M.B. harness (without surcingle)	17	9
	1 case shot cradle	70	7
	Load consisting of—		
	2 case shot boxes		
	1 bar lifting chase ..		
	2 straps for ditto	205	0
	1 trunnion block		
	1 dismounting hammer ..		
	1 strap for ditto		
	Total	293	0
1st ammunition mule.	1 set of M.B. harness (without surcingle)	17	9
	1 ammunition cradle	61	15
	Load consisting of—		
	2 ammunition boxes ..	193	4
	1 strap, overall		
	Total	272	12

Note.—The remaining ammunition mules carry their own line gear and one great-coat in addition to above—23 lb. 1 oz.

DETAIL OF PACKING AND WEIGHTS OF EQUIPMENT—HARNESS—*continued.*

Description of Mule.	Articles carried.	Weight. lb.	Weight. oz.
Pioneer mule.	1 set of M.B. harness (baggage) ..	11	15
	1 G.S. pack-saddle	26	0
	Load consisting of—		
	1 pair sacks, leather, intrenching tools		
	2 axes with helves ..		
	2 sledge-hammers ..		
	4 bill-hooks		
	4 pickaxes, with helves	149	9
	4 implements, intrenching		
	8 fathoms cordage, 1-inch		
	6 small reaping-hooks ..		
	4 hand hatchets.. ..		
	6 helves, spare, of sorts		
	1 pinching bar, 2′ 6″ ..		
	Total	187	8

NOTE.—The line gear of these mules is carried on the relief ammunition mules of 1, 3, and 5 subdivisions.

Forge mule.	1 set of M.B. harness (without surcingle)	17	9
	1 ammunition cradle	62	0
	Load consisting of—		
	1 smith's anvil		
	1 anvil block		
	1 tool box		
	1 pack-saddle, forge ..		
	1 hammer, handled, uphand	221	8
	1 slice		
	1 poker		
	2 forge straps, 74 in. × $1\frac{1}{2}$ in.		
	1 „ „ 30 in. × $\frac{3}{4}$ in.		
	2 „ „ 26 in. × $\frac{3}{4}$ in.		
	Total	301	1

NOTE.—The line gear of this mule is carried on a spare baggage mule.

DETAIL OF PACKING AND WEIGHTS OF EQUIPMENT—HARNESS—*continued.*

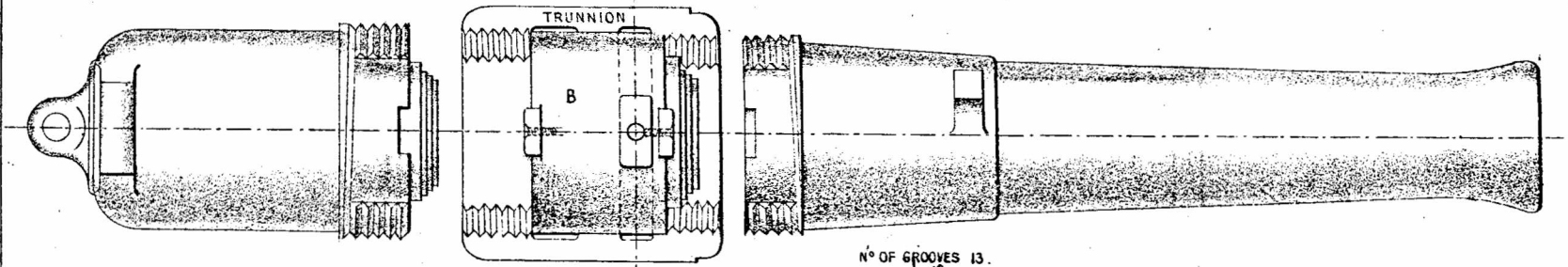
Description of Mule.	Articles carried.	Weight. lb.	Weight. oz.
Artificer's mule.	1 set of M.B. harness (without surcingle)	17	9
	1 ammunition cradle	61	15
	Line gear, &c., with one great-coat	31	11
	Load consisting of— 2 artificers' boxes, containing tools 2 tool holdalls, containing extra tools	206	0
	Total	317	3
Baggage mule.	1 set of M.B. harness	14	0
	1 G.S. pack-saddle	23	0
	Load including line gear and one great-coat	181	5
	Total	221	5

NOTE.—Weight of forage to be added.

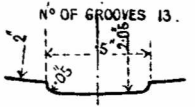
(Wt. 15350 500 11 | 90—H & S 5295)

ORDNANCE, JOINTED, R. M. L. 4 INCH, HOWITZER. (MARK I.) 600 LB. STEEL.

SCALE $\frac{1}{8}$.

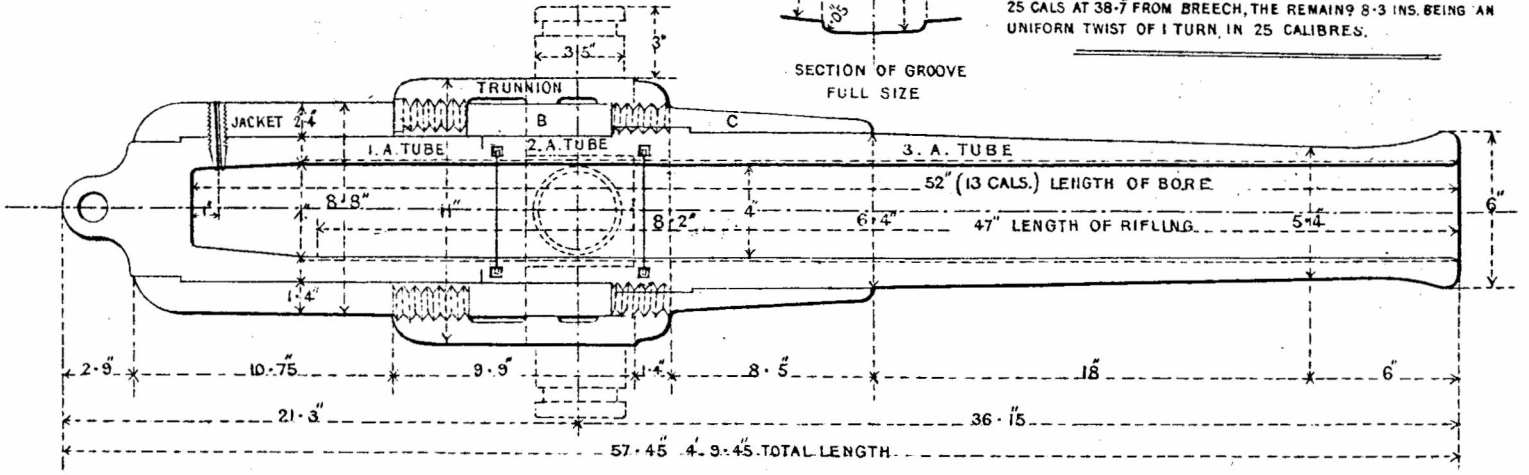


PARTS ARE SHEWN SEPARATE, BUT IN THE LOCKED POSITION



SECTION OF GROOVE FULL SIZE

RIFLING AN INCREASING TWIST FROM 0 AT BREECH TO 1 TURN IN 25 CALS AT 38·7 FROM BREECH, THE REMAINº 8·3 INS. BEING AN UNIFORM TWIST OF 1 TURN IN 25 CALIBRES.



Judd & Co Ltd Lith 73 & 75, Farringdon Rd & Doctors Commons 426. II. 89

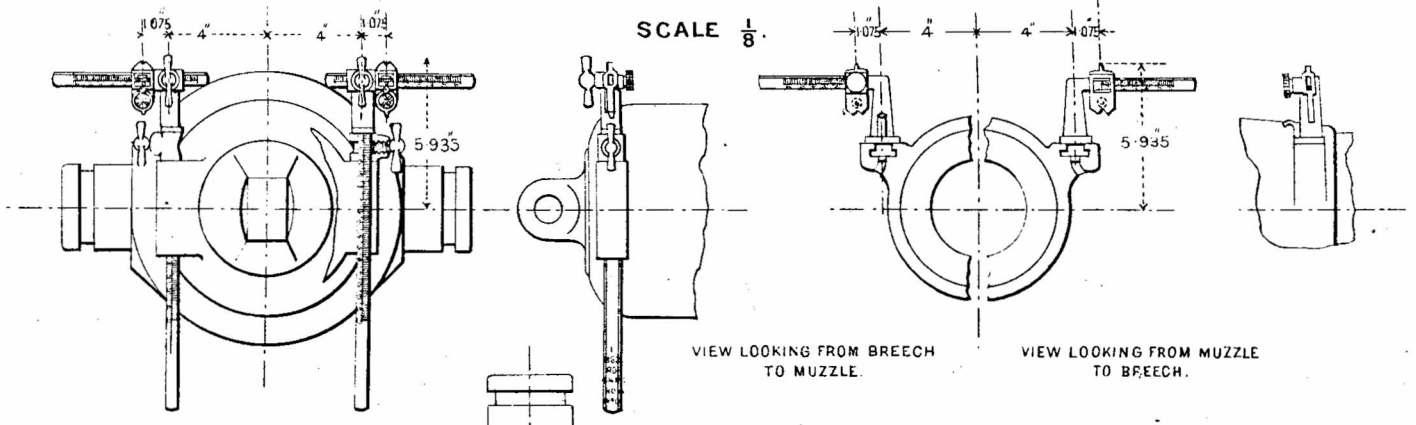
Plate 1.

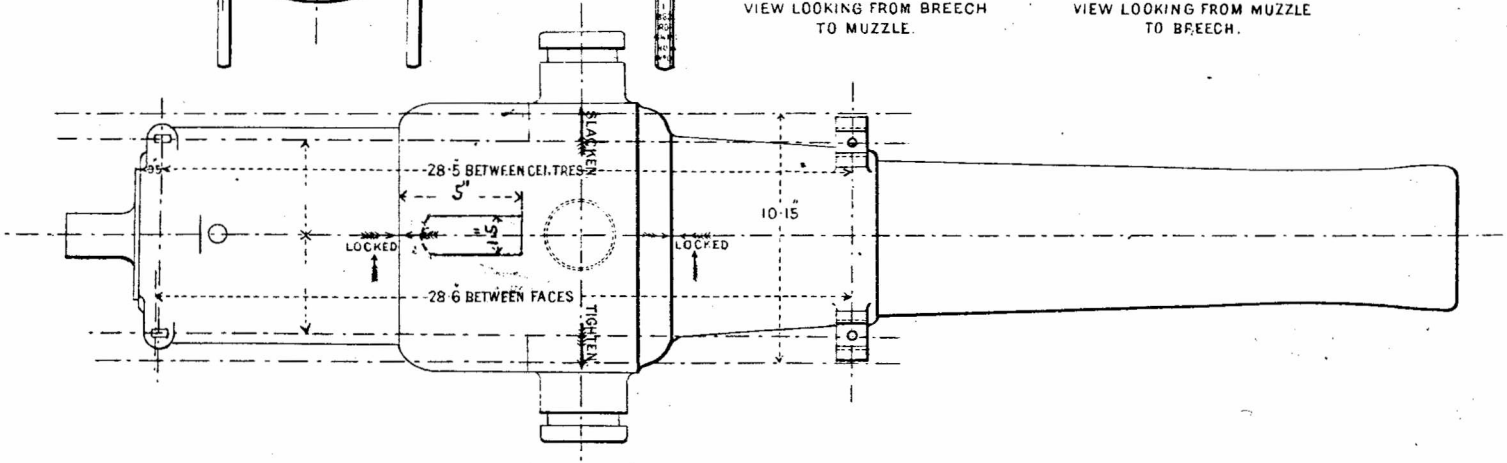
ORDNANCE, JOINTED R.M.L. 4 IN. HOWITZER (MARK I) 600 LB. STEEL.

SIGHTING.

I

SCALE $\frac{1}{8}$.





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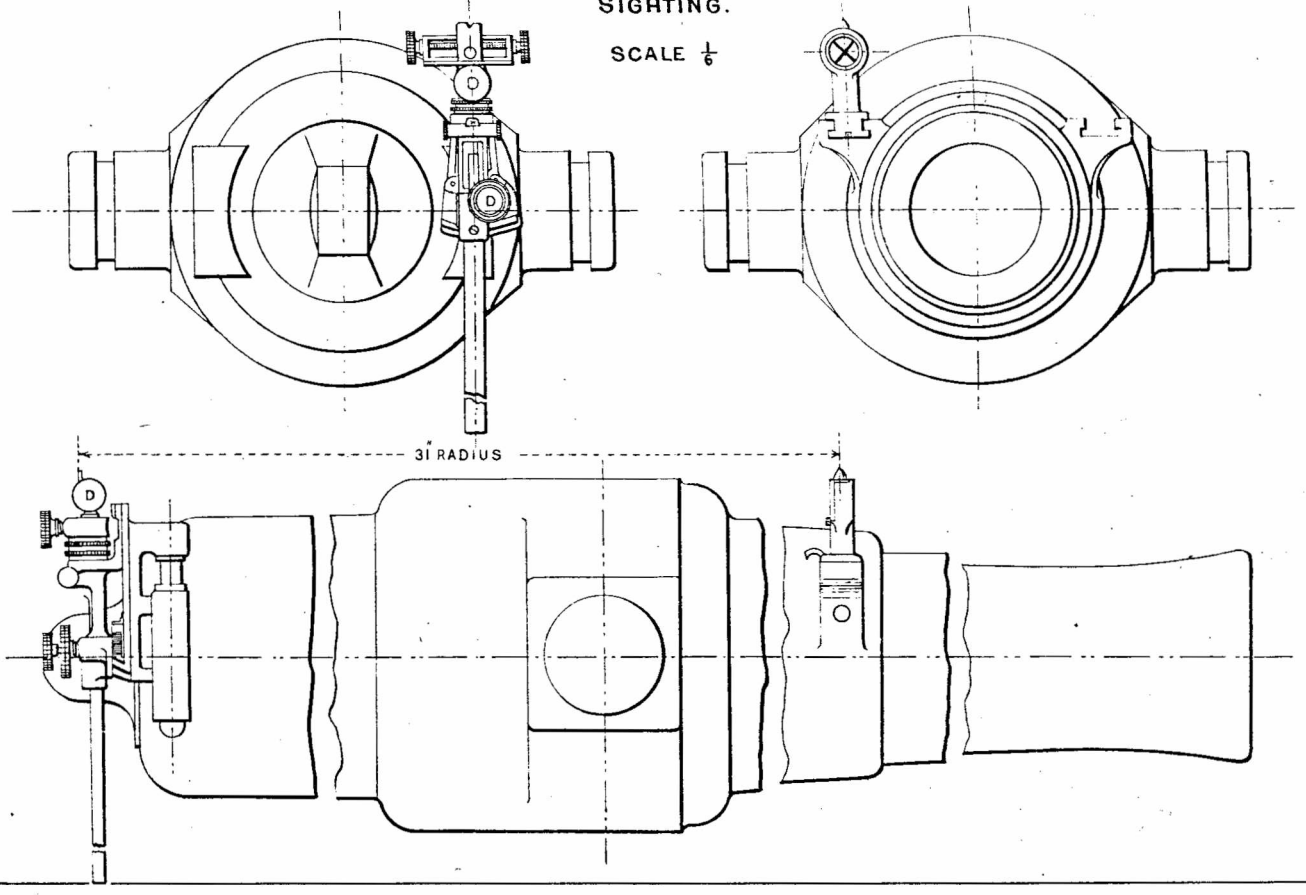
426. 12/89

Plate II.

ORDNANCE, JOINTED R.M.L. 4 INCH HOWITZER MARK I.

SIGHTING.

SCALE $\frac{1}{6}$



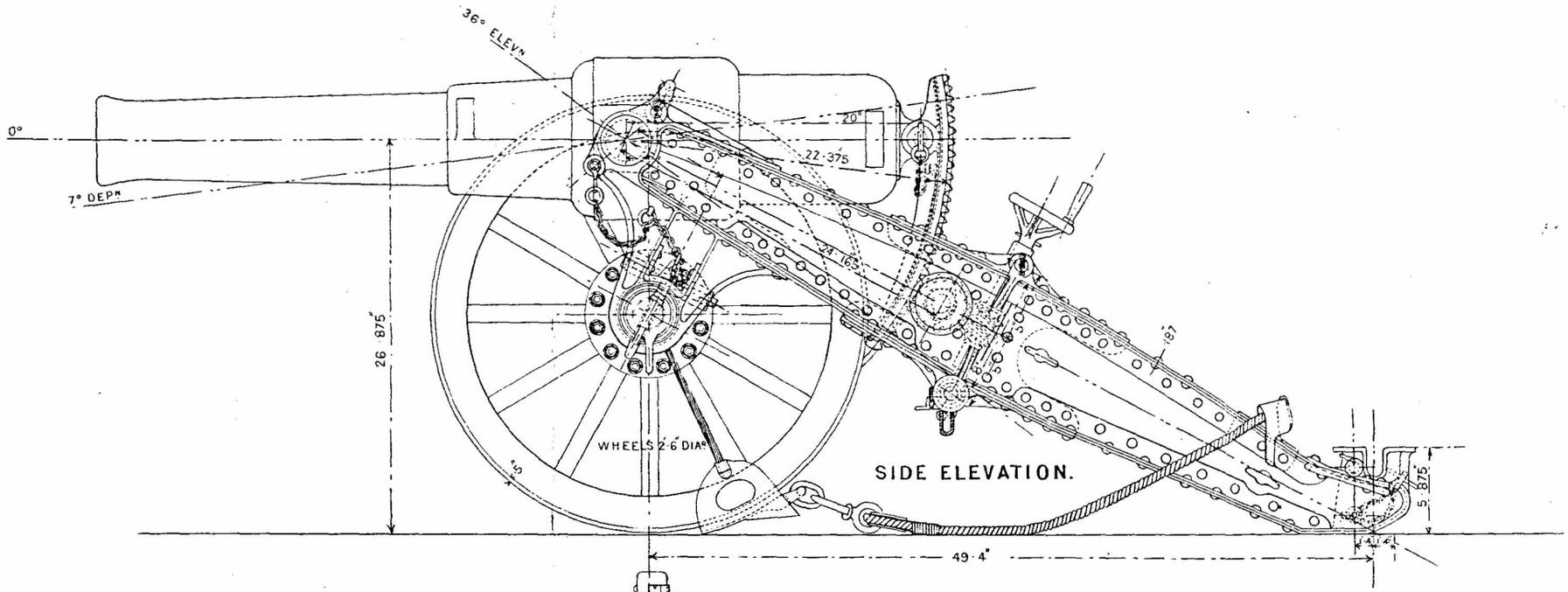
Judd & Co. Lts Lith. 73 & 75, Farringdon Rd & Doctors Commons.

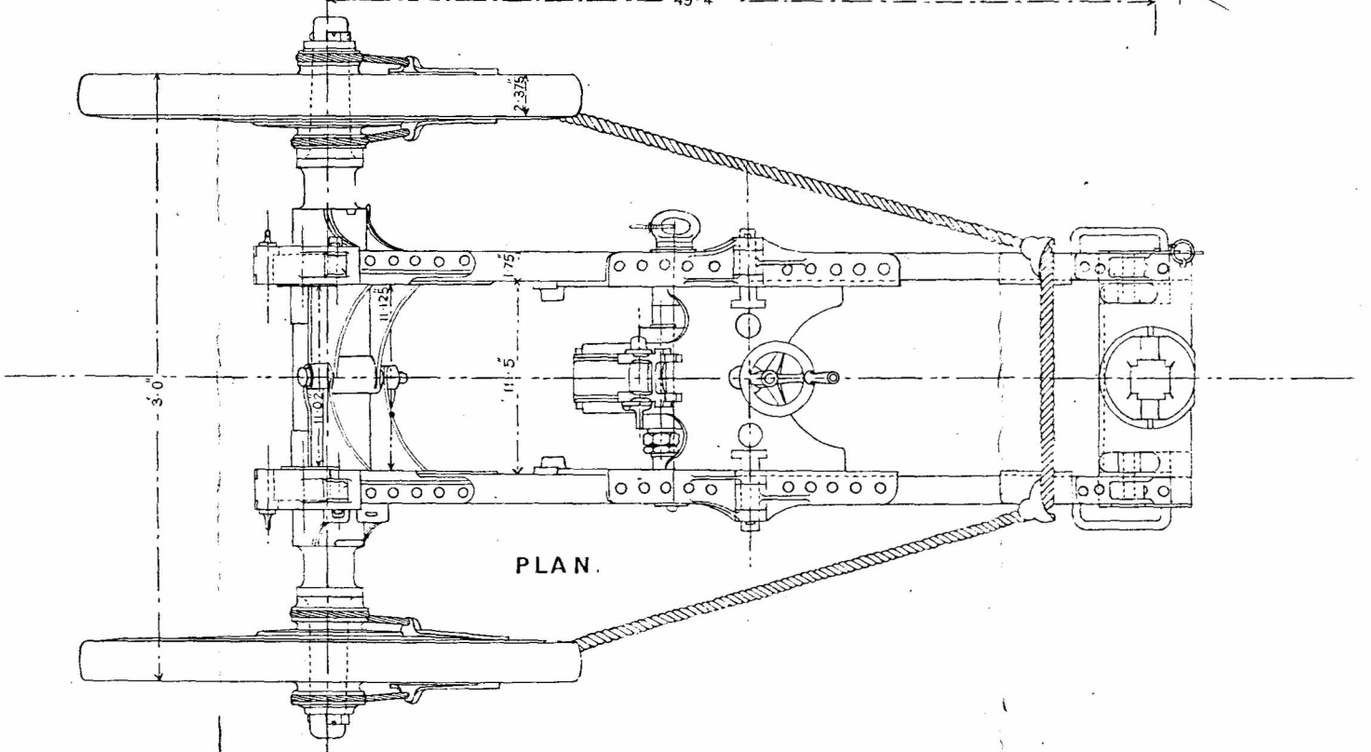
W26/22/89

Plate II.a

CARRIAGE, MOUNTAIN, R.M.L. 4 INCH HOWITZER, MARK I.

STEEL JOINTED.





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426/4/89

PROJECTILES, R.M.L. HOWITZER 4 INCH.

SCALE $\frac{1}{4}$.

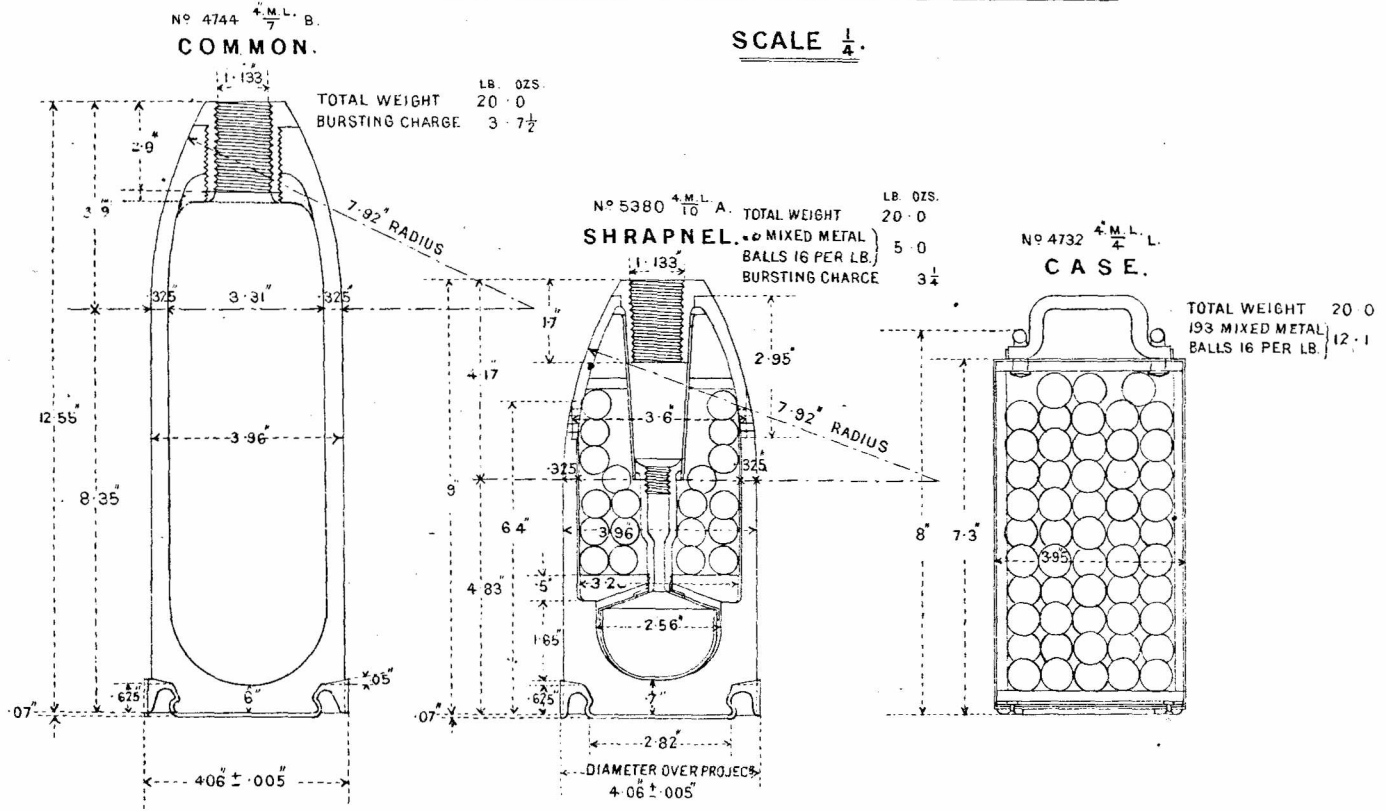

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Plate 11.

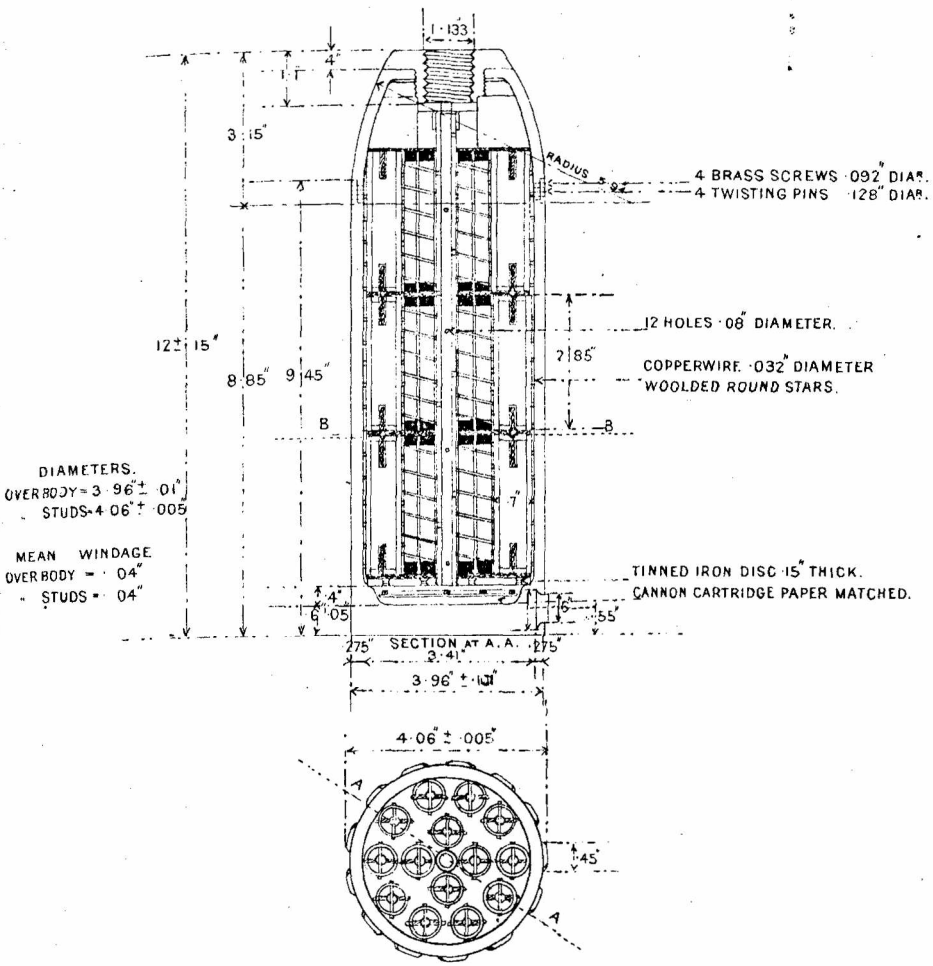
SHELL R.M.L. STAR 4 INCH JOINTED HOWITZER. MARK I.

ELONGATED.

SCALE – $\frac{1}{4}$.

RADIUS OF HEAD = 1·5 DIAMETERS.
LENGTH OF SHELL = 3 CALIBRES.

AVERAGE TOTAL WEIGHT = LB. 16 · OZ. 3½ ± 8 OZ.
42 STARS.



SECTION AT B.B.

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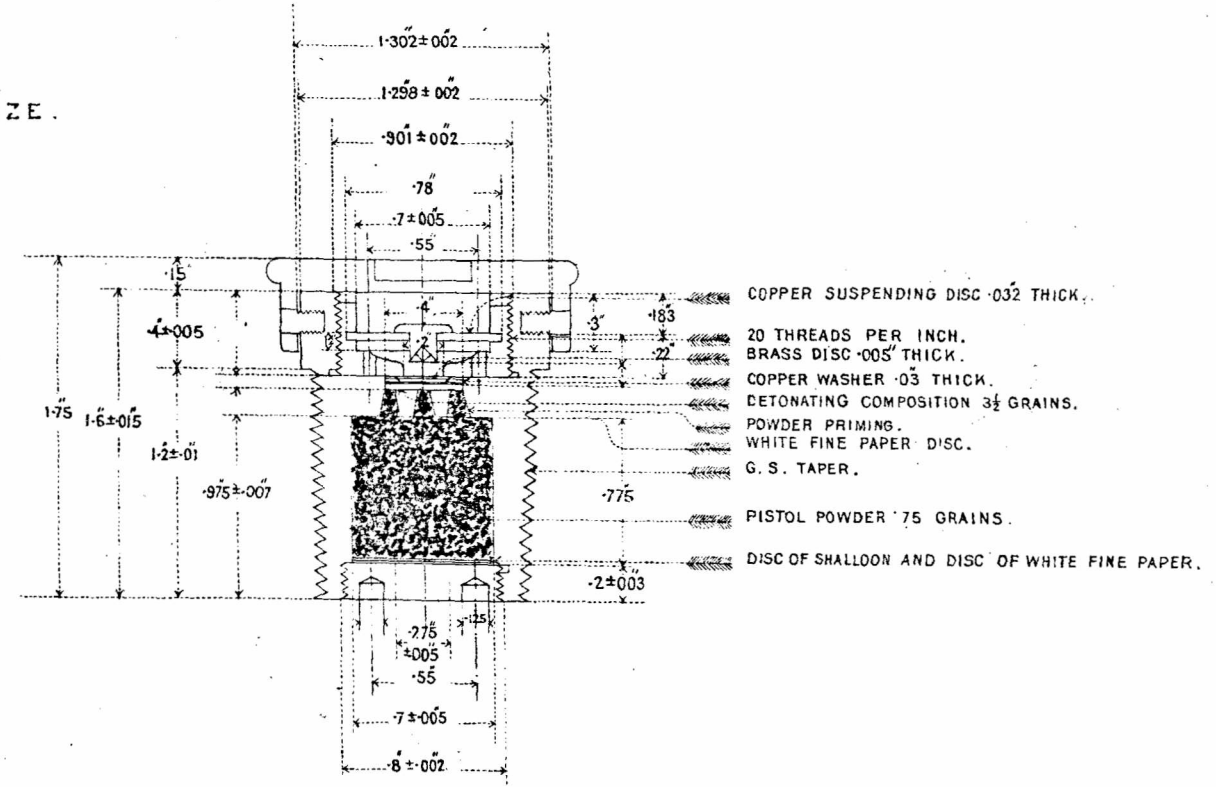
FUZE, PERCUSSION, DIRECT ACTION, Nº 3. MARK II.

METAL 5 IN A TIN CYLINDER.

FULL SIZE.



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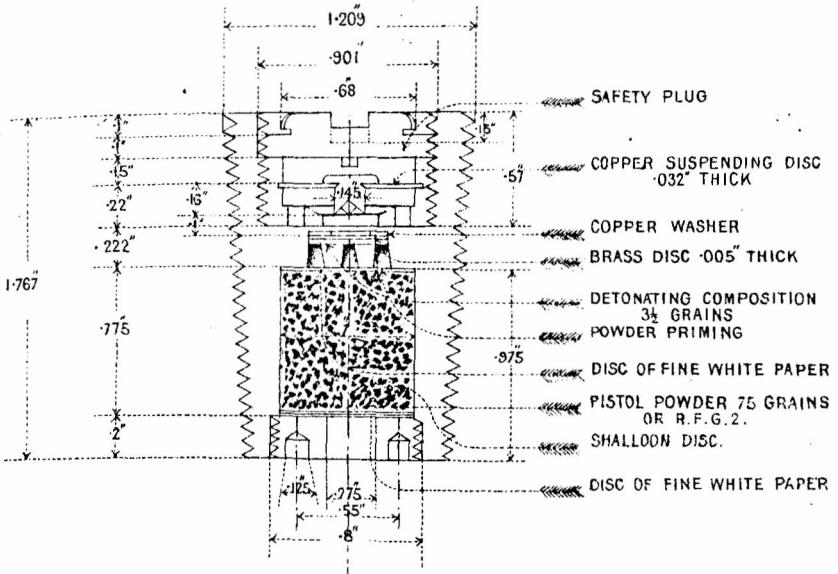
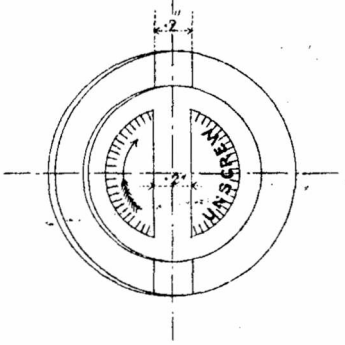
FUZE, PERCUSSION, DIRECT ACTION Nº 3. MARK III

METAL 5 IN A TIN CYLINDER.

FULL SIZE.





PLAN

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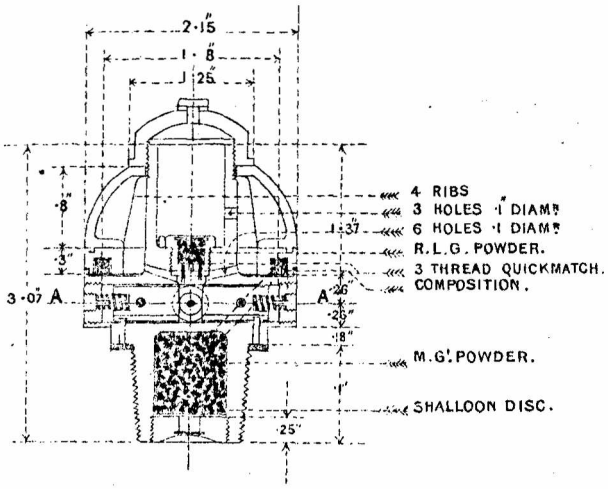
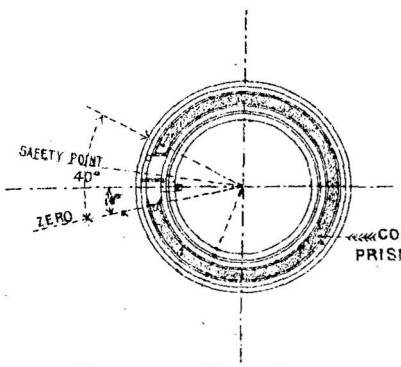
FUZE. TIME, SENSITIVE, MIDDLE, Nº 24. MARK I.

METAL I IN A TIN CYLINDER.

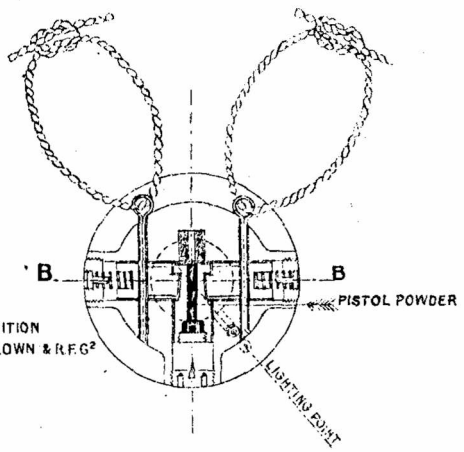
HALF SIZE.



SECTION AT B.B.



PLAN OF RING INVERTED.



SECTION AT A.A.

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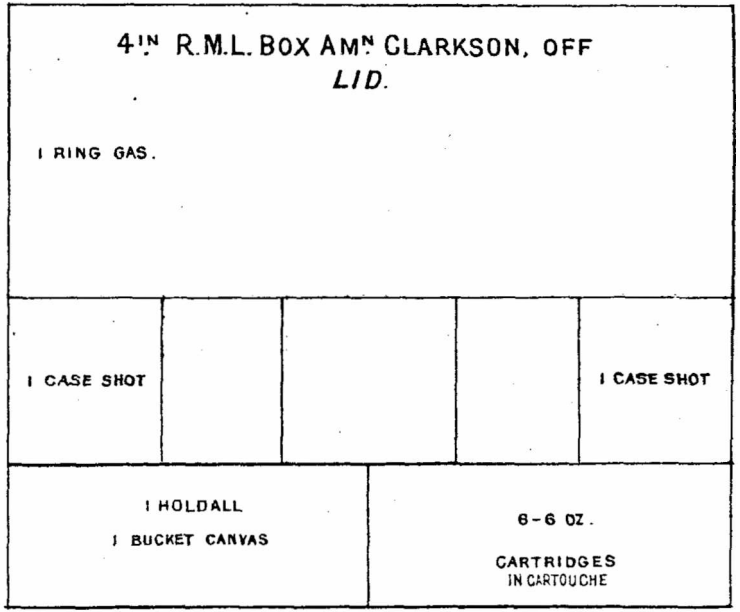
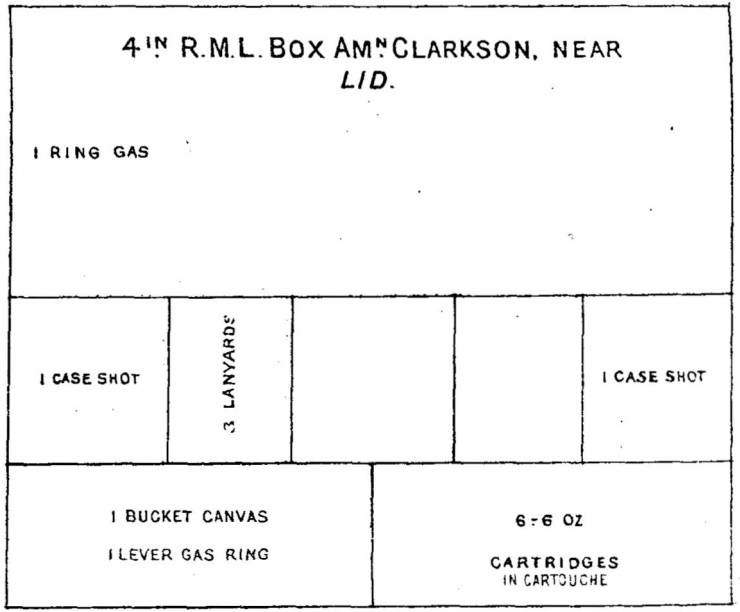
R. M. L. 4 Inch. Howitzer.

CASE SHOT BOXES.





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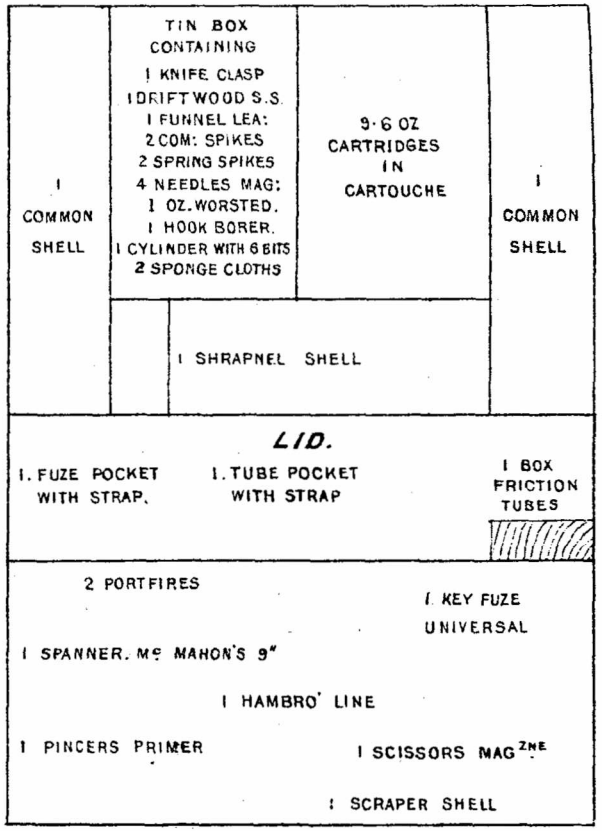
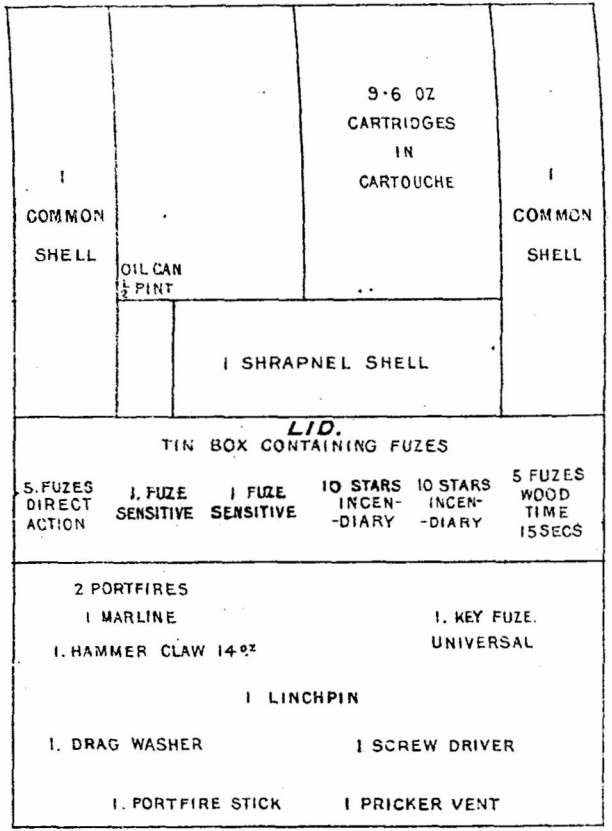
R. M. L. 4 INCH. HOWITZER

BOXES, AMMUNITION.

OFF BOX



NEAR BOX



N.B. This diagram is only intended to show the place in which each Store is to be carried. The whole of these small Stores are not carried on any one Mule.

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